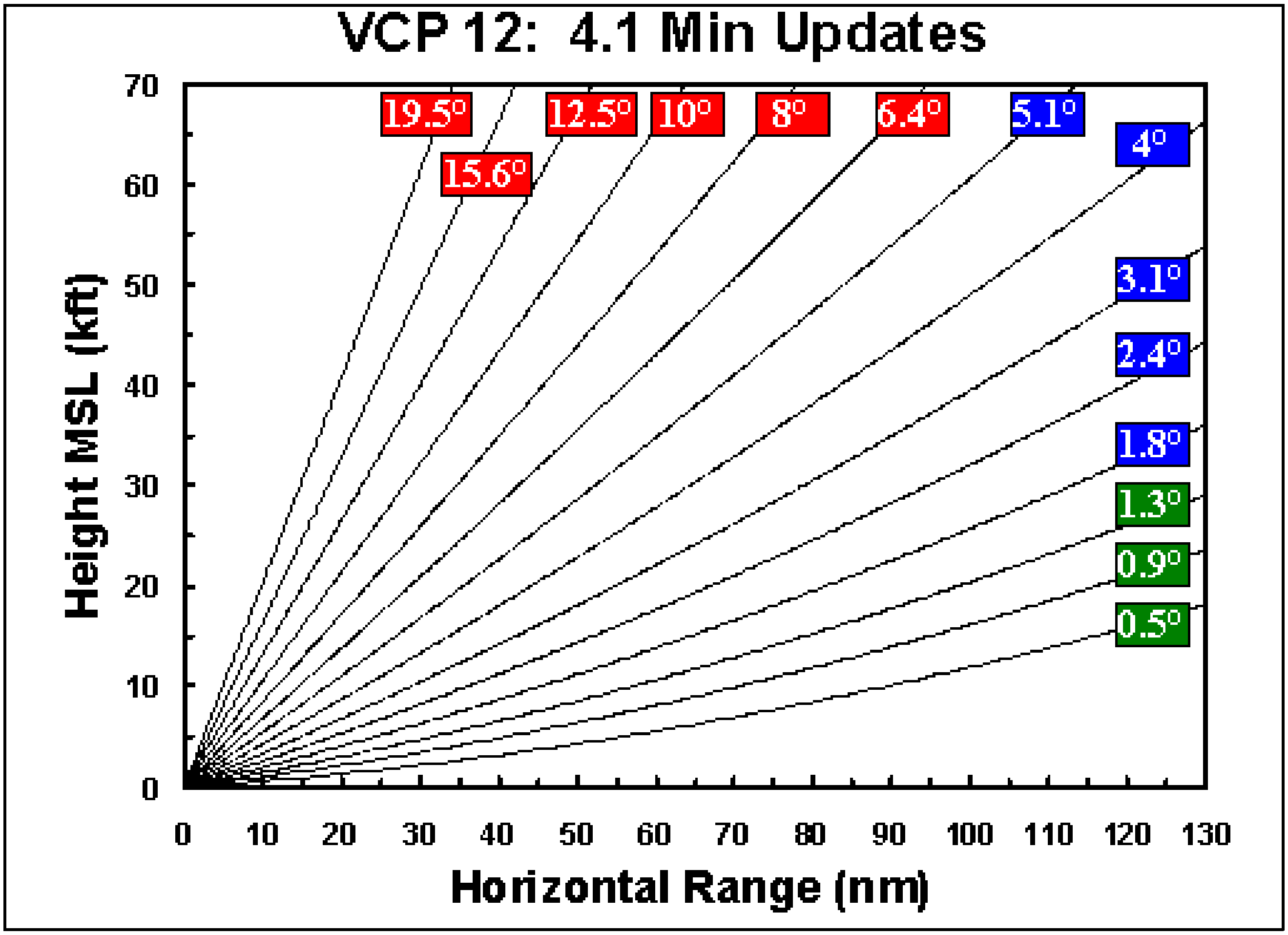
RPG Build 5

Training



Presented by the

Warning Decision Training Branch

Version: 0403

Overview

RPG build upgrades continue on a six month delivery schedule, with RPG Build 5 deployment beginning in late March, 2004. Each RPG build has a blend of new science, upgrades to existing products or algorithms, as well as fixes. Features such as new products associated with each RPG build will become available for display and request to NWS forecasters at the AWIPS workstation. The timing of AWIPS implementation of new RPG products will vary, dependent upon the contents and deployment schedule of subsequent AWIPS builds.

This document will present highlights of the operationally relevant changes with RPG Build 5. Some of these changes will be apparent at the RPG Human Computer Interface (HCI). However, the ability to see other changes relies on upgrades to the AWIPS software which will be implemented in later AWIPS builds.

The AWIPS images in this document were captured from a pre-release version of AWIPS OB 3. There may be some differences between these images and comparable ones from the deployed version of AWIPS OB 3.

The following features of RPG Build 5 will be presented in this document:

1. New “Deep Convection” VCP: VCP 12 #
2. Multiple PRF Dealiasing Algorithm (MPDA)
3. Enhanced Precipitation Preprocessing (EPRE)
4. Mesocyclone Detection Algorithm (MDA), Phase 1 *
5. Tornado Detection Algorithm Rapid Update (TRU) *

6. Changes to support real-time Level II data collection
7. Communications upgrades #
8. Changes to the Product Distribution/Comms window

AWIPS OB 3 required for full implementation.

* AWIPS OB 4 required for product display.

Electronic Performance Support System (EPSS)

The Electronic Performance Support System (EPSS) has been updated to support the Build 5 changes that are apparent on the RPG Human Computer Interface (HCI).

1. New “Deep Convection” VCP: VCP 12

Numbering Convention for New VCPs

In order to accommodate the new VCPs with Build 5 and later builds, the following numbering convention has been established. VCPs are divided into four groups:

- Convection Group: Two digits beginning with the number 1; VCPs 11 and 12 are in this group.
- Shallow Precipitation Group: Two digits beginning with the number 2; VCP 21 is in this group.
- Clear Air Group: Two digits beginning with the number 3; VCPs 31 and 32 are in this group.
- Multiple PRF Dealiasing Algorithm (MPDA) Group: Three digits beginning with the number 1, followed by the 2 digit number of the VCP

with similar elevation angles; VCP 121 is the MPDA VCP with elevation angles similar to VCP 21.

VCP 12 Characteristics

VCP 12 is the first of several new VCPs which may be implemented in the future. VCP 12 was designed for sampling convection with better vertical resolution and a faster update than VCP 11. Denser vertical sampling at the lower elevation angles will provide better vertical definition of storm structure. VCP 12 improves the detection capabilities of radars impacted by terrain blockage for better rainfall and snowfall estimates. More storms will be identified for interrogation by the WSR-88D meteorological algorithms. Tracking and trending parameters from volume scan to volume scan will improve at middle and far ranges.

See Figure 1 and Figure 2 for a comparison of VCPs 11 and 12, respectively. As an example of VCP 12's better low level vertical resolution, note that VCP 12 has 6 elevations below 4°, while VCP 11 has 4 elevations.

VCP 12 Waveforms

VCP 12 uses the Split Cut waveform (Contiguous Surveillance mode [CS], then Contiguous Doppler mode [CD]) for the lowest 3 elevations, while VCP 11 uses the Split Cut for the lowest 2 levels. The Batch (B) waveform is used from 1.8° to 5.1° with VCP 12 and from 2.4° to 6.2° with VCP 11 (and the other legacy VCPs). This has implications for clutter filtering with respect to the low vs. high segments.

Software Modification to Support Clutter Filtering

Software Modification Note 23 instructs the electronics technician to change the clutter segment transition angle from 2.0° to 1.65° at the RDA. This transition angle is the separation from the low to high segment for clutter filtering. After this change,

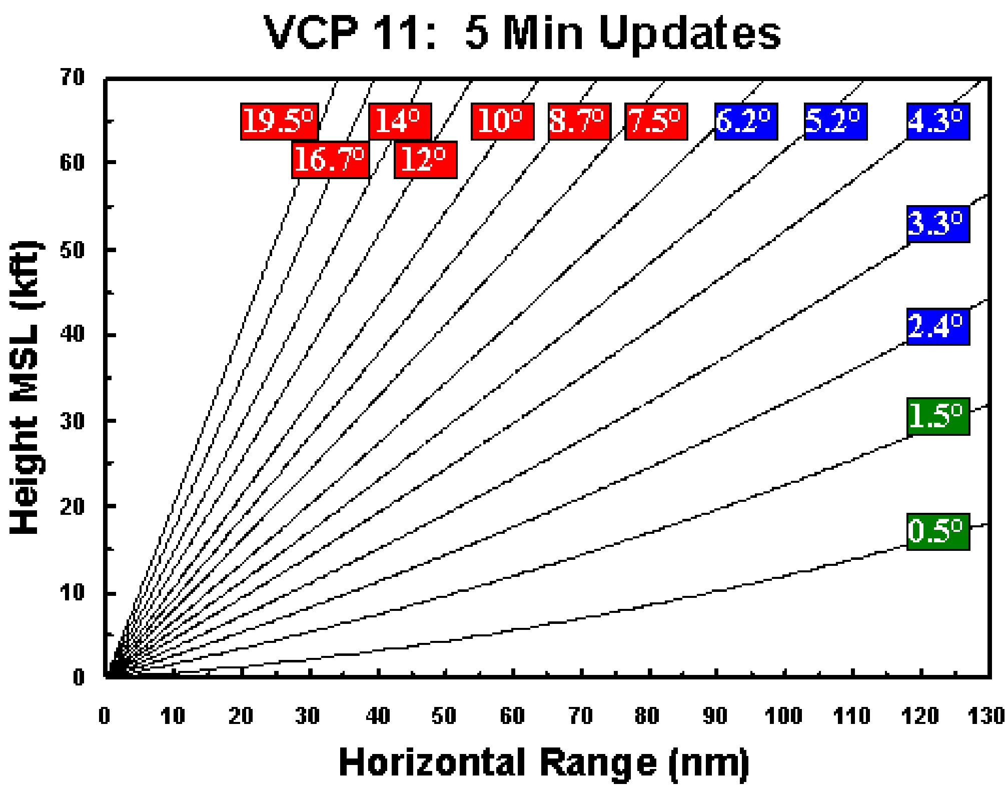


Figure 1. VCP 11 elevation angles.

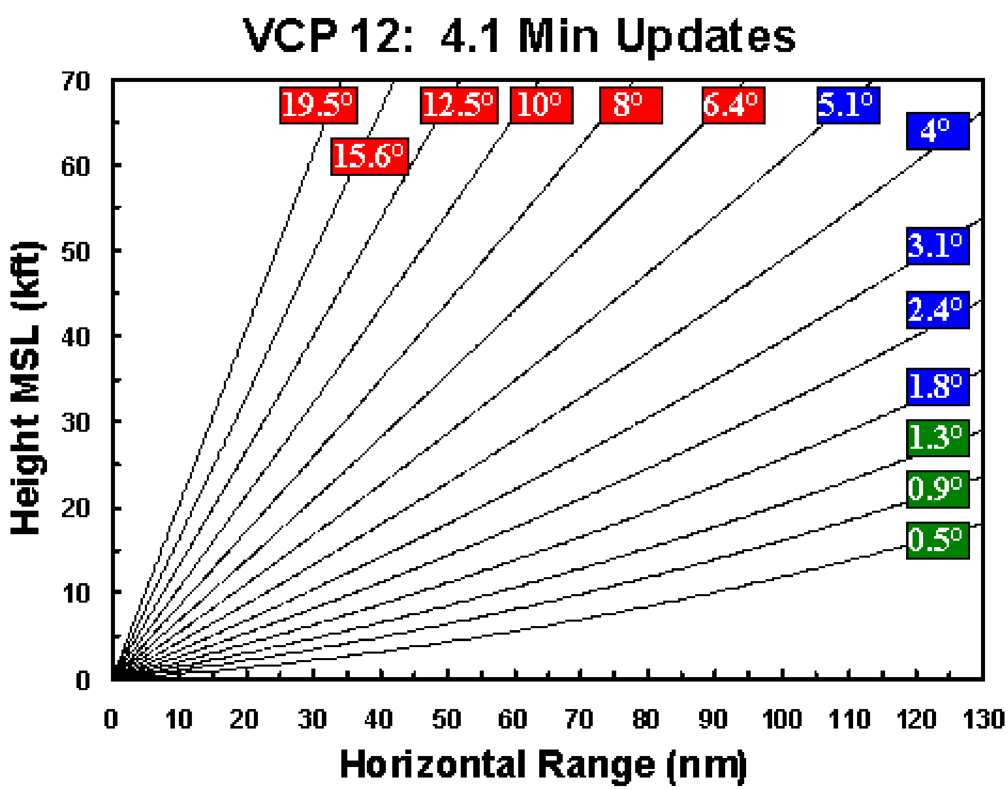


Figure 2. VCP 12 elevation angles.

the RDASOT will be run to update the Clutter Filter Bypass Maps.

The low segment for VCP 12 then includes the angles 0.5°, 0.9°, and 1.3° (Split Cut), while VCP 11 remains at 0.5° and 1.5° (Split Cut). Offices are reminded that performing clutter filtering on the Batch elevations will employ significantly wider notch widths. Clutter filtering should be limited to the low segment (below 1.65°) if possible.

This RDA software modification ***must*** be completed before loading Build 5.

VCP 12 and AWIPS OB 3

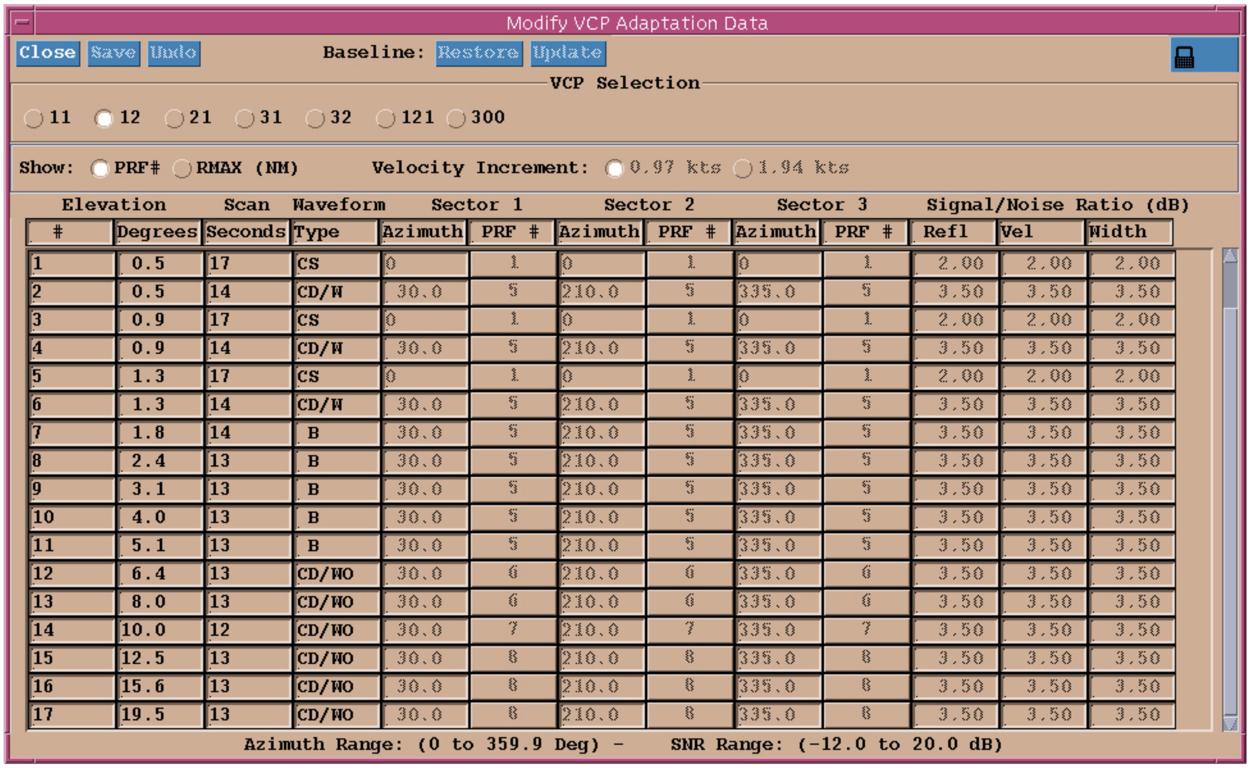
Do not use VCP 12 until AWIPS OB 3 has been installed at your WFO, any WFOs who are associated users, and your backup WFOs!

If VCP 12 is used and the products are displayed at an AWIPS with OB 2, the ***only viewable*** base products will be at 0.5°, 2.4°, 10.0°, and 19.5°.

Adaptation VCP 12

Figure 3 displays the Adaptation version of VCP 12, which would become the current VCP when downloaded. Note that the Doppler PRF for the Split Cut and Batch elevations is PRF #5. As with the legacy VCPs, Auto PRF can be employed with VCP 12 to minimize range folding overall. However, if PRF #4 (longest R_{max}) is desired, or a particular storm is masked, a manual PRF change will be needed.

The faster antenna rotation rates of VCP 12 will result in fewer pulses per radial compared to VCP 11. However, any potential loss in base data quality is within the Nexrad Technical Requirement, which is a reflectivity accuracy of ± 1 dBZ and a velocity accuracy of ± 1 m/s. Furthermore, for the



Elevation		Scan	Waveform	Sector 1		Sector 2		Sector 3		Signal/Noise Ratio (dB)		
#	Degrees	Seconds	Type	Azimuth	PRF #	Azimuth	PRF #	Azimuth	PRF #	Refl	Vel	Width
1	0.5	17	CS	0	1	0	1	0	1	2.00	2.00	2.00
2	0.5	14	CD/W	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
3	0.9	17	CS	0	1	0	1	0	1	2.00	2.00	2.00
4	0.9	14	CD/W	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
5	1.3	17	CS	0	1	0	1	0	1	2.00	2.00	2.00
6	1.3	14	CD/W	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
7	1.8	14	B	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
8	2.4	13	B	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
9	3.1	13	B	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
10	4.0	13	B	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
11	5.1	13	B	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
12	6.4	13	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
13	8.0	13	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
14	10.0	12	CD/WO	30.0	7	210.0	7	335.0	7	3.50	3.50	3.50
15	12.5	13	CD/WO	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
16	15.6	13	CD/WO	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
17	19.5	13	CD/WO	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50

Figure 3. VCP 12 angles, waveforms and PRFs.

lowest two elevations, 0.5° and 0.9°, VCP 12 uses the ***same*** antenna rotation rates as for 0.5° and 1.5° in VCP 11.

Invoking VCP 12

The legacy VCPs are stored at both the RPG ***and*** the RDA. For example, the Change command is used to invoke the RDA version of VCP 11, while the Download command is used to invoke the RPG version of VCP 11. Unlike the legacy VCPs, VCP 12 is ***only*** stored at the RPG. Thus the only way to invoke VCP 12 is to use the Download command (Figure 4). Note that the VCP 12 button is located where the VCP 21 button used to be!

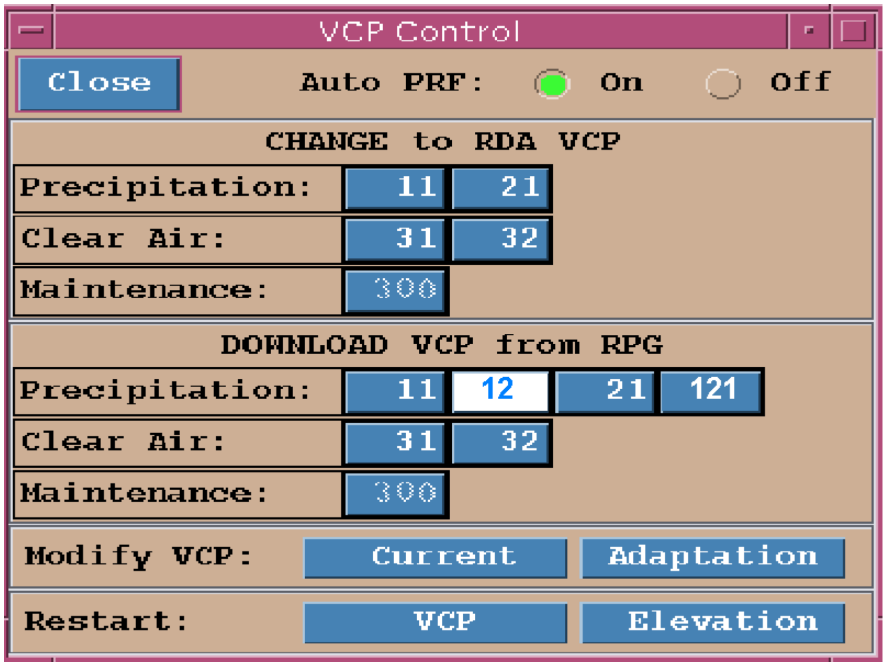


Figure 4. VCP Control window with RDA and RPG versions of the VCPs.

Changes to the RPG Control Window

At the RPG Control window, the Default Weather Mode (Precipitation or Clear Air) can be selected at the URC level. There are also buttons to select a default VCP for each of the weather modes, Clear Air or Precipitation. However, these parameters are at the ROC level and cannot yet be edited.

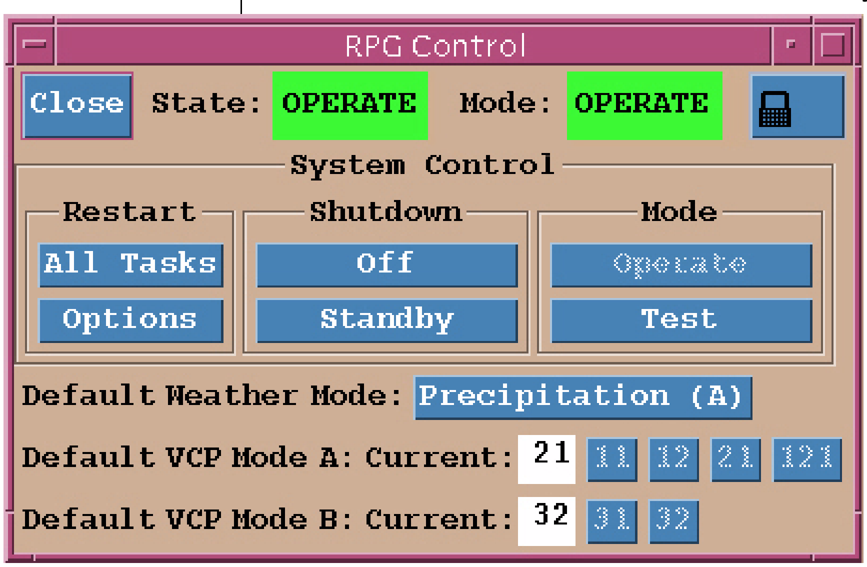


Figure 5. RPG Control window, including Default VCP selection.

VCP Explorer

The VCP Explorer is a training tool developed by the National Severe Storms Laboratory that supports NWS meteorologist's familiarization with the new and legacy VCPs. This visualization tool is a web-based Java application that is platform independent and allows the user to dynamically interact with:

- the choice of any WSR-88D,
- any radar azimuth,
- the choice of any new or legacy VCP,
- a PPI map with local terrain, and
- a RHI map with terrain cross-section.

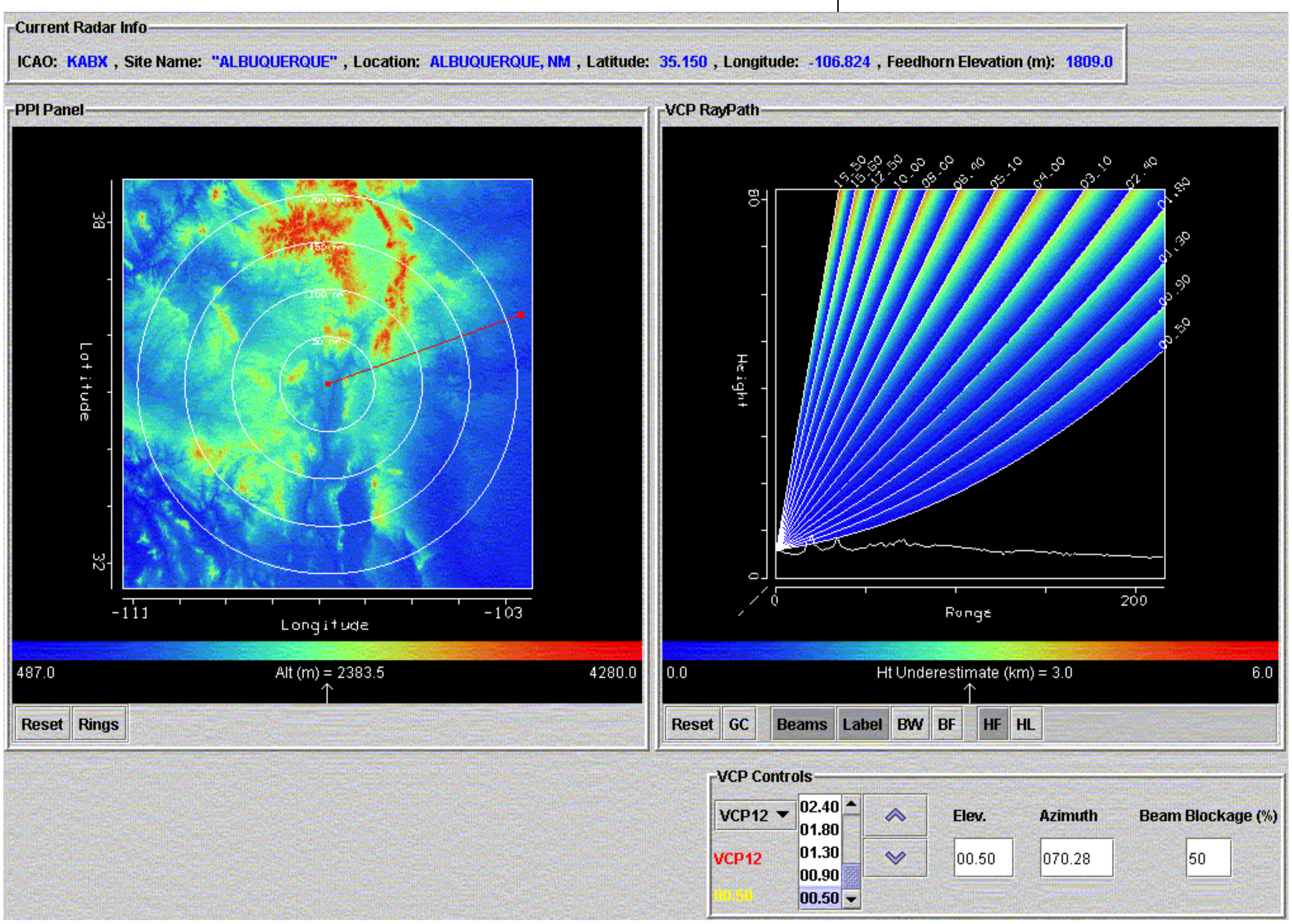


Figure 6. VCP Explorer with VCP 12 selected.

Figure 6 shows the VCP Explorer interface. WDTB expects to ship the first version (a CD and instructional material) to each NWS office in early Spring.

2. Multiple PRF Dealiasing Algorithm (MPDA)

The Multiple PRF Dealiasing Algorithm (MPDA) is designed to mitigate both range folding and improperly dealiased velocities. There are many considerations for when and how to use the MPDA. It will provide the best results with events that have widespread echo coverage with significant range folding even when using Auto PRF or a specified Doppler PRF.

The MPDA will provide base data with significantly less range folding and an improvement in velocity dealiasing. Though both improvements are the result of the MPDA, the reduction in range folding will likely be more apparent. The expected reduction in range folding is 50-70 %.

MPDA is a Short Term Solution

The MPDA is intended to be a short term solution to the problem of both range and velocity folding. A hardware solution is under development and will be fielded some time after the Open Radar Data Acquisition (ORDA) is deployed.

Applying MPDA

Applying the MPDA requires downloading VCP 121, which is used solely for the MPDA. VCP 121 samples elevation angles similar to VCP 21, but the lower angles have additional rotations in Contiguous Doppler (CD) mode. For example, at 0.5°, there is first a rotation in Contiguous Surveillance (CS) mode, followed by three rotations in CD mode. Each of the CD rotations employs a different Doppler PRF. For a particular range bin, range folding will typically not result for all of the three Doppler PRFs, and the velocity value(s) that are available are then used by the MPDA.

MPDA Development Example

In the following example from the development of the MPDA, the results from each of the three Doppler PRFs are shown. The final velocity product after the MPDA has processed the three CD rotations is also presented. In this example, there is a squall line oriented north through south (Figure 7).

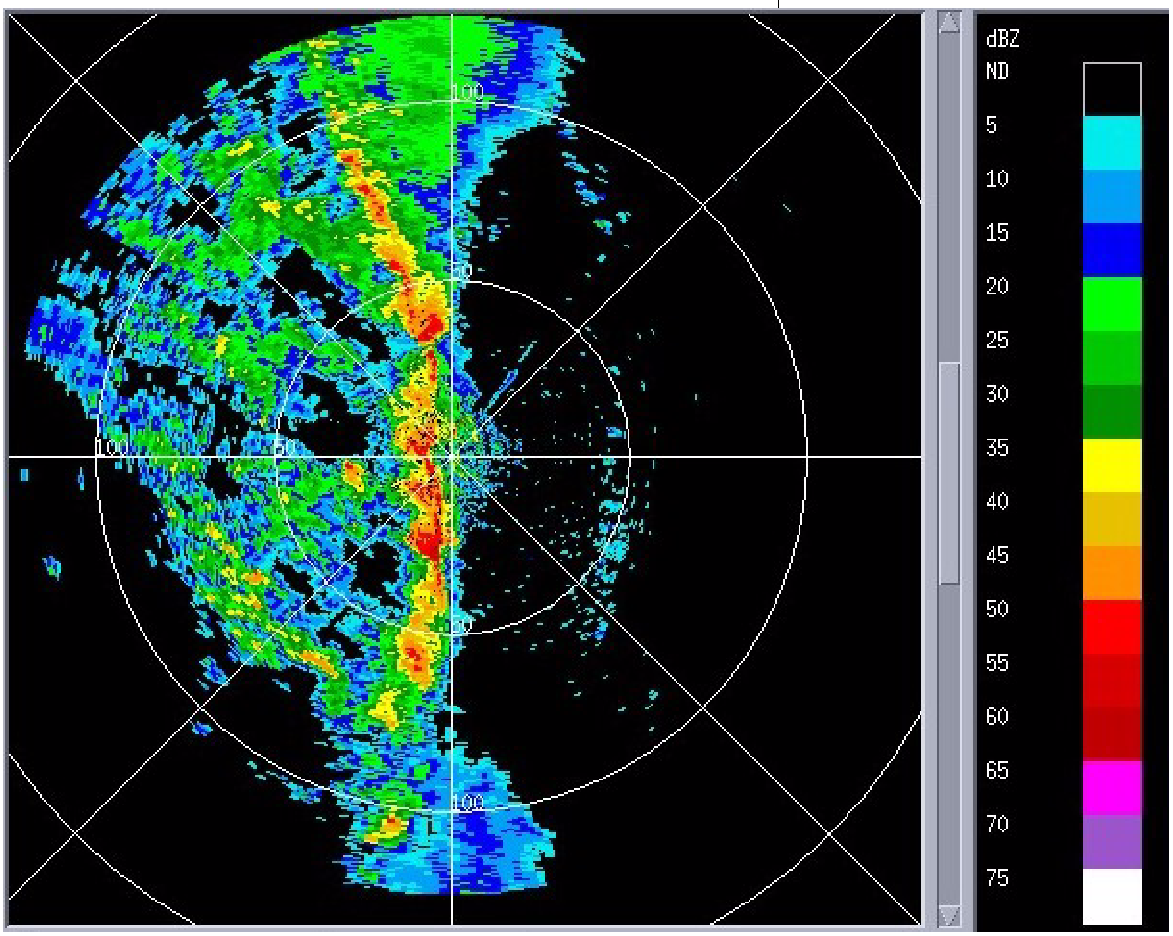


Figure 7. Squall line case for MPDA.

There are three CD rotations, using PRFs 8, 6, and 4, respectively. Figure 8 shows these three data sets after range unfolding has been performed. For the first CD rotation (PRF #8), Range Unfolding is performed ***at the RDA***. For the second and third rotations, range unfolding is performed ***at the RPG***. The MPDA uses these data for its processing.

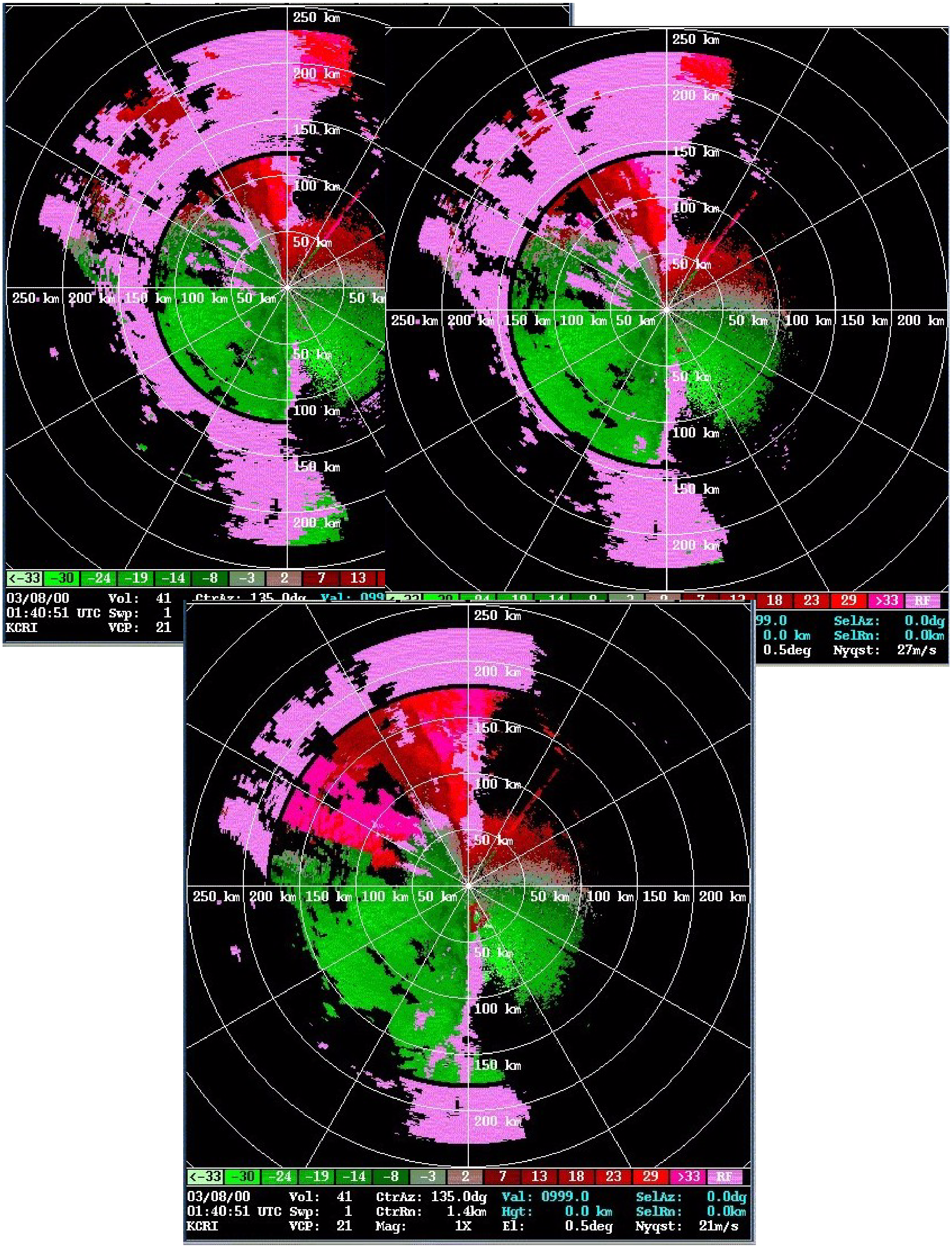


Figure 8. Results from Doppler PRFs 8 (top left), 6 (top right), and 4 (bottom).

See Figure 9 for the velocity product after MPDA processing. Note that the range folding over the entire product is significantly reduced, as compared with the velocity display from each of the three CD data sets individually.

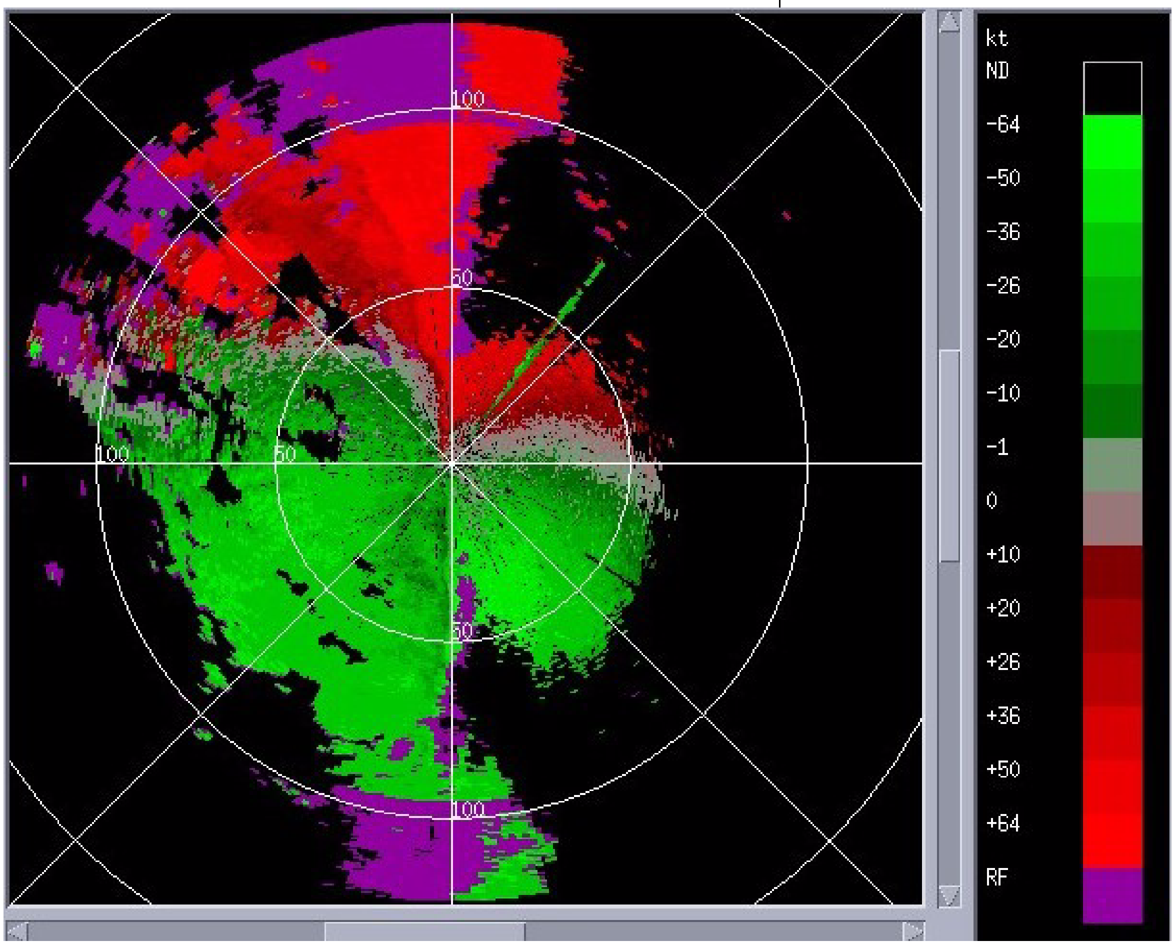
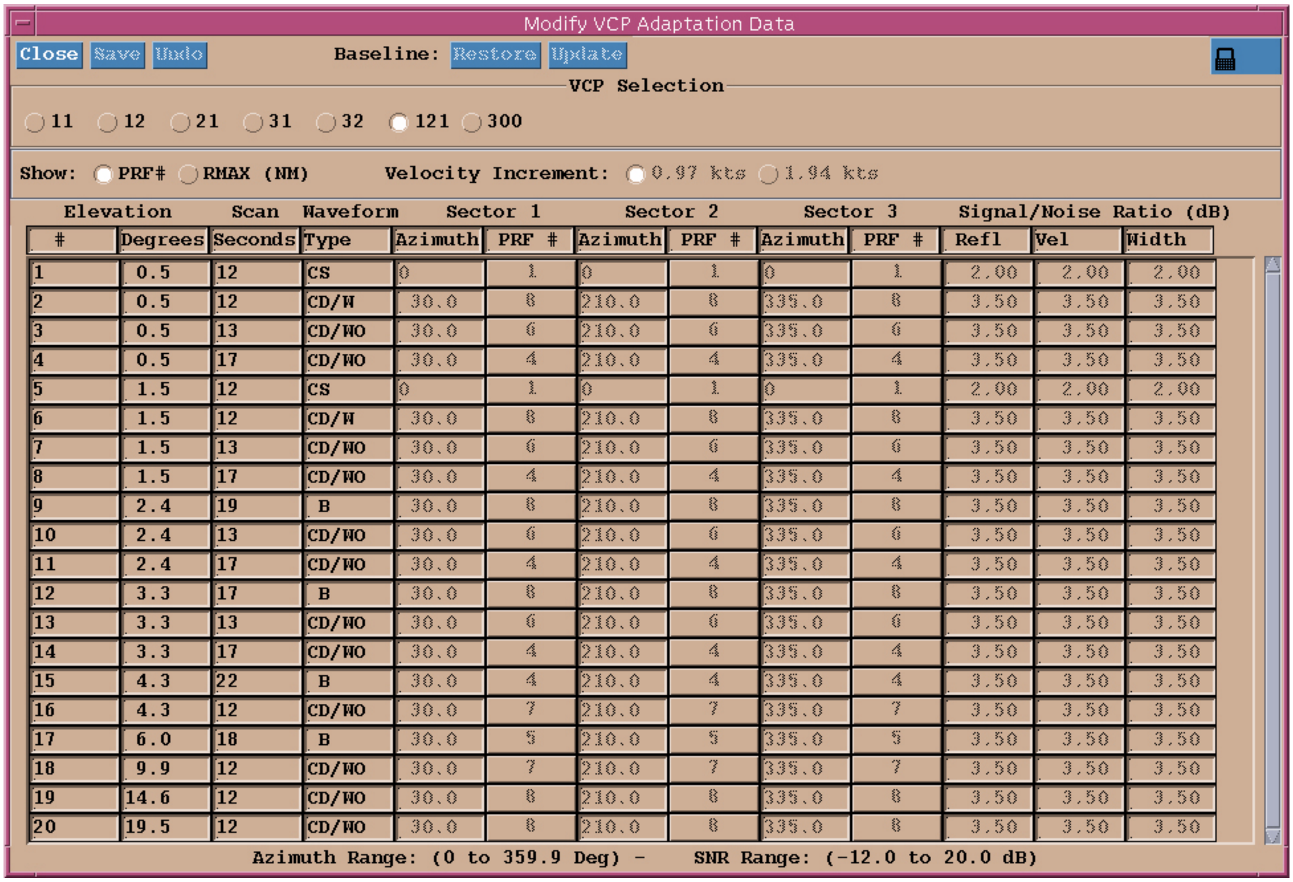


Figure 9. Results after MPDA processing.

VCP 121

The only way to employ the MPDA is to download VCP 121. VCP 121 is best thought of as the “MPDA version of VCP 21” with an update of just under 5 minutes. The MPDA is performed on the lowest 5 elevations. For the lowest two elevations, 0.5° and 1.5°, there is one rotation in CS mode, followed by three rotations in CD mode. For the 2.4°, 3.4°, and 4.3° elevations, the first rotation is in Batch (B) mode, which alternates between a CS and CD mode PRF. The initial B mode rotation is followed by one or two CD rotations (Figure 10).



Elevation		Scan	Waveform	Sector 1		Sector 2		Sector 3		Signal/Noise Ratio (dB)		
#	Degrees	Seconds	Type	Azimuth	PRF #	Azimuth	PRF #	Azimuth	PRF #	Refl	Vel	Width
1	0.5	12	CS	0	1	0	1	0	1	2.00	2.00	2.00
2	0.5	12	CD/W	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
3	0.5	13	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
4	0.5	17	CD/WO	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
5	1.5	12	CS	0	1	0	1	0	1	2.00	2.00	2.00
6	1.5	12	CD/W	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
7	1.5	13	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
8	1.5	17	CD/WO	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
9	2.4	19	B	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
10	2.4	13	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
11	2.4	17	CD/WO	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
12	3.3	17	B	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
13	3.3	13	CD/WO	30.0	6	210.0	6	335.0	6	3.50	3.50	3.50
14	3.3	17	CD/WO	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
15	4.3	22	B	30.0	4	210.0	4	335.0	4	3.50	3.50	3.50
16	4.3	12	CD/WO	30.0	7	210.0	7	335.0	7	3.50	3.50	3.50
17	6.0	18	B	30.0	5	210.0	5	335.0	5	3.50	3.50	3.50
18	9.9	12	CD/WO	30.0	7	210.0	7	335.0	7	3.50	3.50	3.50
19	14.6	12	CD/WO	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50
20	19.5	12	CD/WO	30.0	8	210.0	8	335.0	8	3.50	3.50	3.50

Figure 10. Adaptation VCP 121.

In Figure 10, there are two different types of the CD waveform, listed as CD/W or CD/WO. This classification difference pertains to whether or not Range Unfolding has been performed ***as received from the RDA***. CD/W indicates that Range Unfolding is performed ***at the RDA***. Since the MPDA is processed at the RPG, Range Unfolding for the additional CD rotations is performed ***at the RPG***.

VCP 121 Considerations

There are a total of 20 rotations for VCP 121, and ***the volume scan update rate is just under 5 minutes***. In order to accomplish 20 rotations in 5 minutes, VCP 121 has higher antenna rotation rates than VCP 21. Another consideration is that the additional CD rotations result in transitions from 0.5° to 1.5° and from 1.5° to 2.4° that are about 30 seconds longer than VCP 21.

Though extra time is required to complete the additional scans at the lower elevations, it is expected that for most cases completion times are sufficiently short so that meteorological features are not distorted either by movement or by evolution. The possibility of distortion is reduced due to the faster rotation rates of each scan. However, VCP 121 may ***not*** be appropriate for fast moving or rapidly evolving storms.

Another consideration for the use of VCP 121 would be the vertical resolution of the elevation angles, particularly compared to VCP 12. With tornadic storms, especially close to the RDA, VCP 12 offers the advantage of viewing the base data with enhanced low level vertical resolution. If the Mesocyclone Rapid Update (MRU) is being used, VCP 12 would provide faster results than VCP 121.

Invoking VCP 121

The legacy VCPs are stored at both the RPG and the RDA. For example, the Change command is used to invoke the RDA version of VCP 11, while the Download command is used to invoke the RPG version of VCP 11. Unlike the legacy VCPs, VCP 121 is ***only*** stored at the RPG. Thus the only way to invoke VCP 121 is to use the Download command (Figure 11).

MPDA Processing for a Single Range Bin

The MPDA uses input from multiple CD scans at the same elevation angle. For example, at 0.5° and 1.5°, there are three CD rotations. For most range bins, this will result in two or three velocity estimates available for MPDA processing.

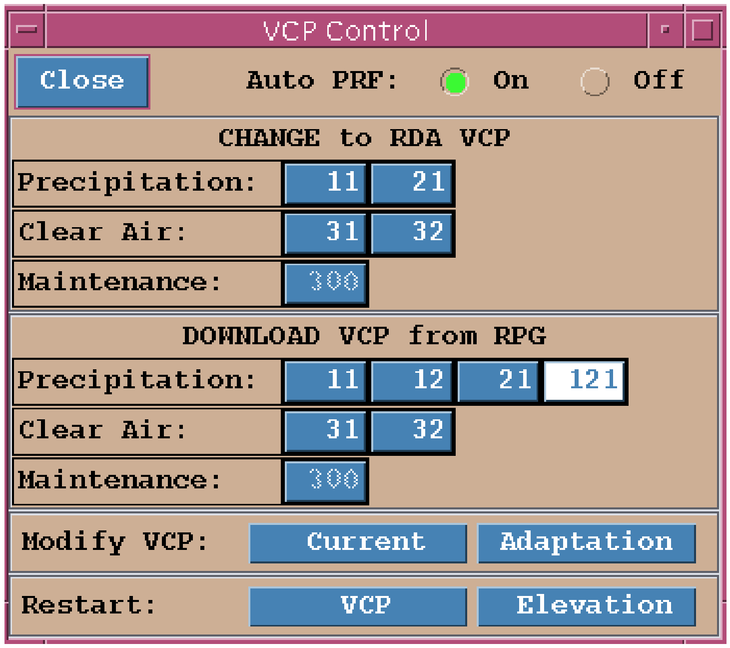


Figure 11. VCP Control window at the RPG HCI.

Three Velocity Values Available

For each of the three CD rotations, assume that the following first guess velocity (V_{fg}) values are initially determined for a particular range bin.

1. PRF #8, V_{max} = 61 kts, V_{fg} = -58 kts
2. PRF #6, V_{max} = 52 kts, V_{fg} = -41 kts
3. PRF #4, V_{max} = 41 kts, V_{fg} = -20 kts

Since Range Unfolding has been performed on each of the CD rotations, the ***location*** (range and azimuth) is known, but the appropriate velocity value to place in that range bin must be determined. Each CD rotation results in a first guess velocity and an associated V_{max}. MPDA looks at the possible velocities for each of these rotations to see if there is a common velocity value (within a small threshold). The equation is

$$V_p = V_{fg} \pm 2nV_{max}$$

where

- V_p is a possible velocity,
- V_{fg} is the first guess velocity,
- V_{max} is the maximum unambiguous velocity, and
- n is an integer.

For n=1, there is a common velocity.

1. -58 + 2(61) = +64 kts

2. -41 + 2(52) = +63 kts

3. -20 + 2(41) = +62 kts

In this example, the velocity value used is the one that came from the highest PRF.

If there is no common velocity among the three, the process is repeated among the possible pairs (PRFs 8&6, 8&4, and 6&4). The first pair that converges is used.

Note that the dealiasing step has already been performed. When two or three velocity values are available, there is no dealiasing check performed with neighboring velocities.

Two Velocity Values Available

Due to range folding at any of the PRFs, two velocity values may be all that are available at an elevation angle. The process for two velocity values is the same as with three, looking for a common velocity value.

One Velocity Value Available

Due to range folding at any of the PRFs, a single velocity value may be all that is available at an elevation. In this case, a process similar to the legacy Velocity Dealiasing Algorithm is performed. The single first guess velocity is compared to neighboring value(s). In the case where three or two velocities do not converge, the best fitting single velocity value is used.

Range Folding Assignment with MPDA

With the MPDA, the assignment of range folding for a particular range bin and the color purple on the velocity products will result from either of the following cases:

1. All velocities from the available CD rotations were range folded (no velocity estimates available), or
2. All but one velocity from the available CD rotations were range folded, and the remaining one had missing data (below the signal to noise ratio).

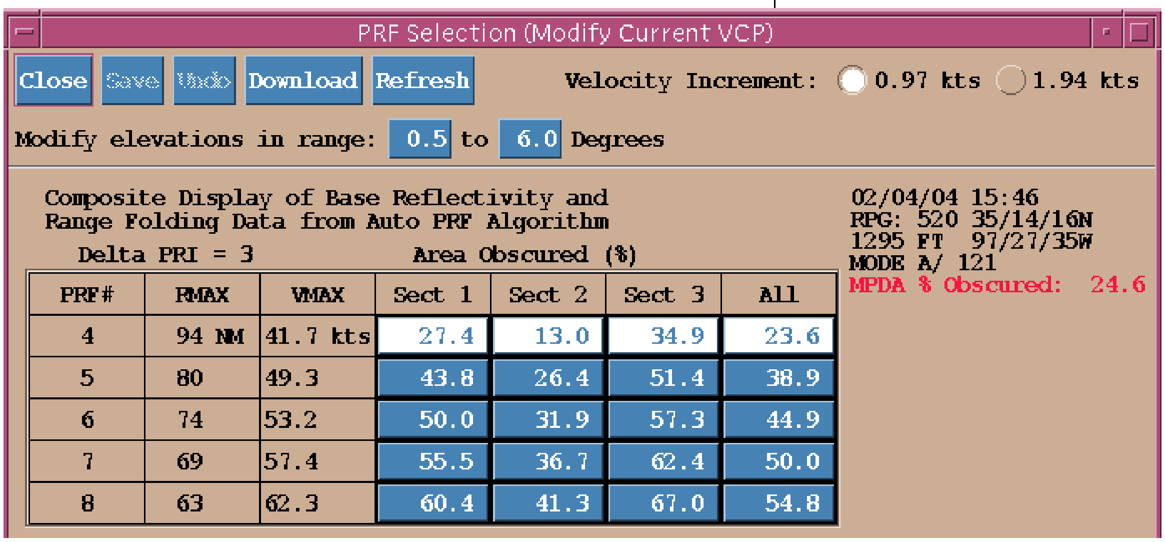
MPDA (VCP 121) and Auto PRF

Auto PRF analyzes the areal coverage of range folding for each of the Doppler PRFs (#4, 5, 6, 7, and 8) using the 0.5° elevation data. When Auto PRF is set to "on", the Doppler PRF that results in the minimum overall coverage of purple is inserted into the current VCP. The VCP is then downloaded to the RDA for use during the next volume scan. Allowing Auto PRF to select and download a Doppler PRF each volume scan would obviously interfere with the input necessary for the MPDA.

Once VCP 121 is active, the download portion of Auto PRF's function is automatically disabled. Auto PRF will still perform the calculations of areal coverage of range folding at 0.5° for each Doppler PRF, but no PRF selection is made or downloaded. However, while VCP 121 is running, the Auto PRF status will still show "on" unless the operator has manually selected "off". This is the same behavior that exists when operating in VCP 31.

MPDA and PRF Selection

When VCP 121 is the current VCP, the percentage of range folded data from the MPDA is available at the PRF Selection window (Figure 12).



PRF#	RMAX	VMAX	Sect 1	Sect 2	Sect 3	All
4	94 NM	41.7 kts	27.4	13.0	34.9	23.6
5	80	49.3	43.8	26.4	51.4	38.9
6	74	53.2	50.0	31.9	57.3	44.9
7	69	57.4	55.5	36.7	62.4	50.0
8	63	62.3	60.4	41.3	67.0	54.8

Figure 12. PRF Selection window at the RPG HCI when VCP 121 is active.

MPDA Adaptable Parameters

There are three adaptable parameters with MPDA, which are editable at the URC level. From Figure 13, note that the title for the MPDA is Velocity Dealiasing - Multi PRF.

In Figure 13, the first parameter is the Range Unfold Power Difference Threshold. Since some of the CD rotations are range unfolded at the RPG, it is necessary to have a parameter that provides the same function as the adaptable parameter TOVER at the RDA. Both of these parameters define a threshold power difference between echoes that are overlaid (from different trips) into the same apparent range in the first trip. The default value for the Range Unfold Power Difference Threshold is 5 dB, which is also the default value for TOVER. ***It is recommended that these two parameters always be set to the same value.***

Note that the units for the Range Unfold Power Difference Threshold are shown as dBZ. The units are actually in dB, and this will be corrected in a later build.

The second two parameters, Fix Trip Minimum Bin and Fix Trip Maximum Bin, address noisy velocity data that may appear at the end of the first trip. If it is persistent, these two parameters define an annulus around the end of the first trip where the noisy data will be removed. Since the range for each of the CD rotations varies, these parameters are stated as an integer number of bins, rather than minimum and maximum ranges. The default values, 0 and -1 respectively, allow for no data removal. The suggested implementation is to leave the minimum bin at 0 and expand the number of maximum bins as needed.

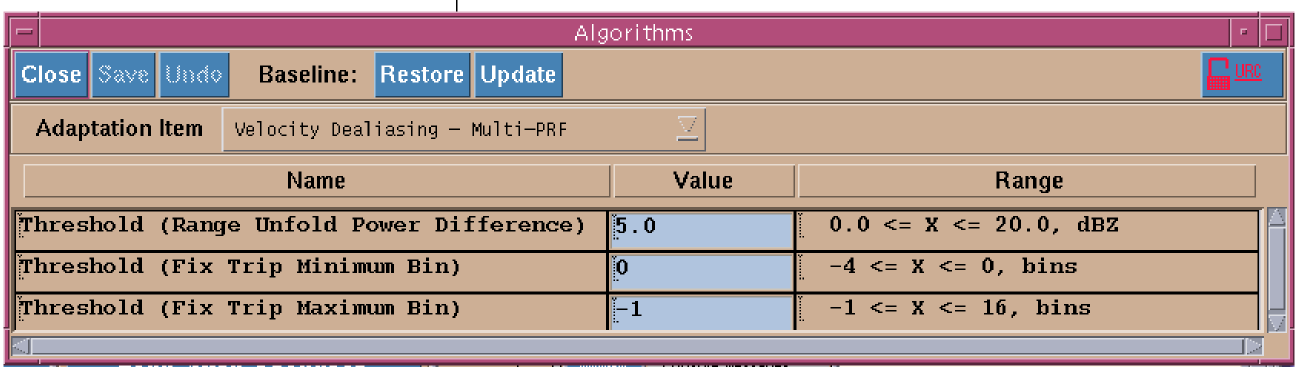


Figure 13. MPDA adaptable parameters.

Strengths of MPDA

1. The MPDA can be expected to provide the best results with

a. hurricanes (except with tornadoes near the RDA),

b. extratropical cyclones,

c. extensive squall lines, and

d. widely distributed storms where sectoring for different PRFs isn't feasible.

2. Velocity dealiasing failures are less likely to occur on the leading edge of returns.

Limitations of MPDA

1. The MPDA will not be the best choice for

a. tornadic storms, especially fast moving storms close to the RDA,

b. clear air,

c. any situation where fast results from the MRU are a priority.

2. The most likely locations for velocity dealiasing failures are unknown to the operator (where a single velocity value is from PRF #4).

3. Enhanced Precipitation Preprocessing (EPRE)

The Enhanced Precipitation Preprocessing Algorithm (EPRE) replaces the legacy Precipitation Preprocessing Algorithm. The principal reasons for implementing the EPRE algorithm are to allow for precipitation processing with the new VCPs and to update some of the legacy preprocessing logic. This new logic considers terrain blockage and clutter contamination on a point by point basis in building the Hybrid Scan.

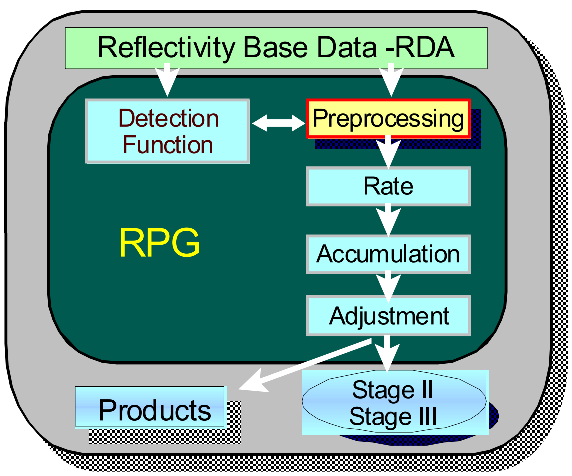


Figure 14. EPRE is a replacement for the legacy Preprocessing algorithm.

The VCP Explorer, described on page 9, may also support understanding the impacts of EPRE, particularly with VCP 12. The interaction of VCP 12's lower angles with the terrain will be apparent with the VCP Explorer.

There are no new precipitation products with Build 5. The EPRE algorithm affects how the reflectivity base data are processed prior to converting to rainfall rate, such as which elevation is used for a particular range and azimuth. There are several operational impacts that affect product generation as well as the user interface, such as changes to adaptable parameters:

- New VCPs
- Precipitation Detection Function (PDF) and EPRE
- Exclusion Zones
- AP/Clutter Removal
- EPRE Effects on Precipitation Product Appearance

New VCPs

The EPRE algorithm provides the necessary changes to accept ***any*** new VCP for precipitation processing. The legacy Precipitation Preprocessing Algorithm was dependent on the lowest four elevation angles of the legacy VCPs, which are all the same. There are new VCPs with Build 5, while others are planned for later builds. The EPRE algorithm accepts any new VCP with elevation angles that differ from the legacy VCPs. The EPRE is not limited to the lowest four elevation angles. Thus the EPRE was necessary to implement VCPs 12 and 121 with RPG Build 5.

Precipitation Detection Function (PDF) and EPRE

Prior to Build 5, the Precipitation Detection Function (PDF) was used to determine whether or not rainfall was to be accumulated by the Precipitation Processing algorithms. This function will now be performed in an analogous way by the EPRE.

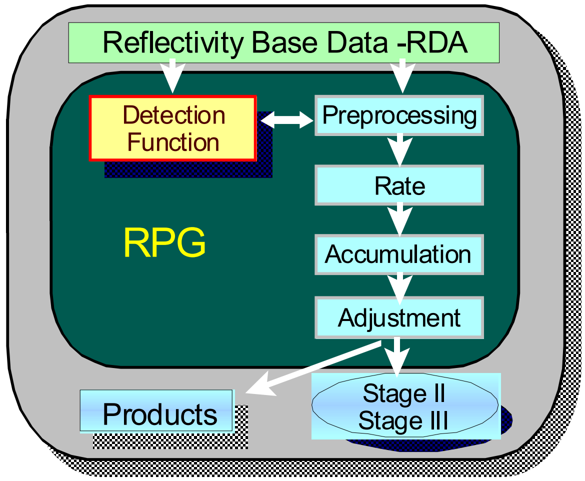


Figure 15. Precipitation Detection Function (PDF).

Review of PDF

Each volume scan, the PDF assigned a category (0, 1, or 2) dependent on the areal coverage of radar returns above a dBZ threshold. The assignment of category 1 or 2 initiated (or continued) the accumulation of rainfall. The assignment of category 0 terminated (zeroed out) rainfall accumulations.

The Nominal Clutter Area (NCA) on the Modify Precipitation Detection Parameters window (Figure 16) is used to account for the areal coverage of residual clutter. Offices can determine a typical value of residual clutter and leave the NCA set to this value.

The sum of the NCA and the Precipitation Area Threshold (which is not editable) determines the areal coverage that must be exceeded in order for rainfall to be accumulated. The Precipitation Rate Threshold determines the minimum dBZ value included in the areal coverage calculation. Though the units are in dBR (decibels of rain rate), their equivalent reflectivity values are:

- Category 2: -2 dBR is equivalent to 22 dBZ,

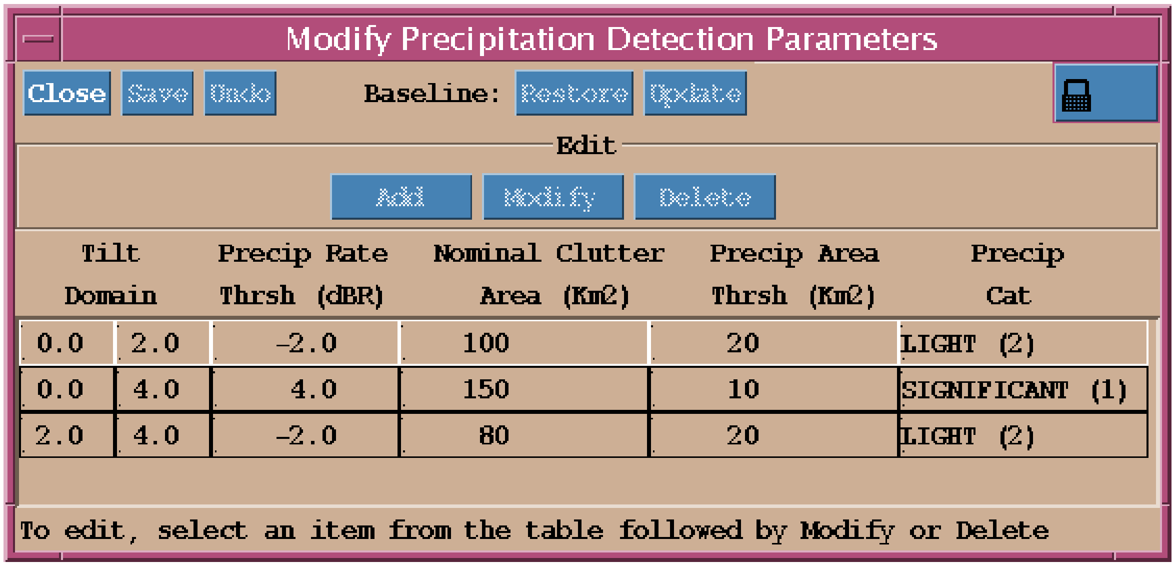


Figure 16. Modify Precipitation Detection Parameters window at the RPG HCI.

- Category 1: 4 dBR is equivalent to 30 dBZ.

The PDF, to some degree, controls the current VCP. If the PDF were to assign category 1 while the radar is in a Clear Air mode VCP, there would be an automatic switch to VCP 21. Once category 1 has been assigned, there is a one hour wait to switch back to Clear Air mode.

How Build 5 Affects the PDF

With Build 5, the PDF ***will no longer control*** when precipitation accumulations begin or end. The PDF ***will still control*** the automatic switch of the radar from a Clear Air mode VCP to VCP 21 when category 1 is assigned. The assignment of category 1 by the PDF ***will also*** continue to trigger the red “Sig” button on the front page of the RPG HCI

Begin and End of Rainfall Accumulations with EPRE

The EPRE includes a function that determines when rainfall accumulations begin and end. This function is performed on the Hybrid Scan after it is assembled. This function is similar to the pre-Build 5 PDF in that there is a threshold of areal coverage of returns greater than a minimum dBZ value. The areal coverage and dBZ thresholds are part of the set of adaptable parameters for the EPRE and are editable (URC). In Figure 17, note that the EPRE adaptable parameters are listed under Hydromet Preprocessing. These parameters are:

- Reflectivity (dBZ) Representing Significant Rain (RAINZ), and
- Area with Reflectivity Exceeding Significant Rain Threshold (RAINA).

The default value for RAINZ is 20.0 dBZ, which is considered to be the lowest dBZ for ***liquid*** precipitable returns.

The default value for RAINA is 80 km^2. For most locations, this areal coverage will likely be too low, resulting in accumulations in clear air. An appropriate setting representing typical residual clutter will need to determined locally.

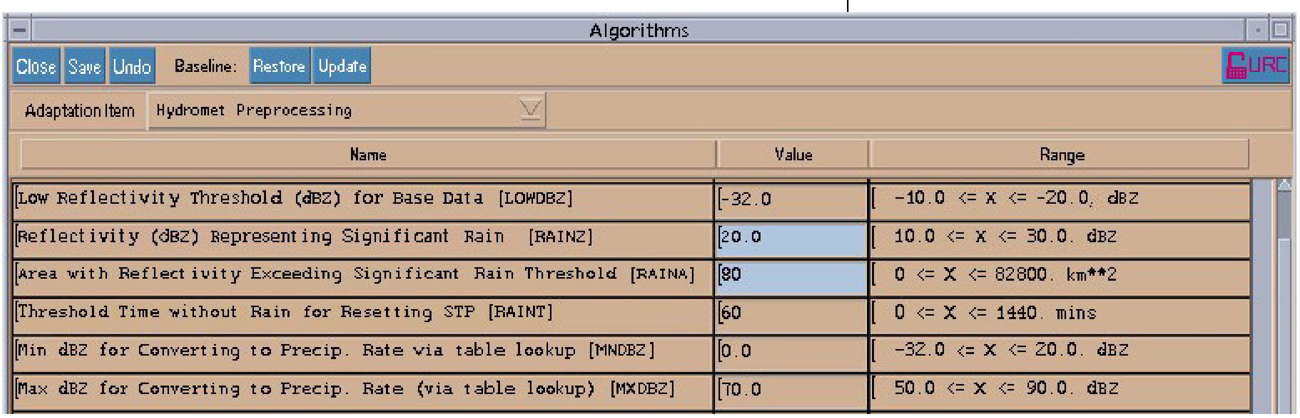


Figure 17. Hydromet Preprocessing (EPRE) adaptable parameters window with URC editable parameters enabled. Note the reflectivity (RAINZ) and areal coverage (RAINA) thresholds.

As with the legacy, there is a one hour waiting period to reset the accumulations to zero. This is controlled by the adaptable parameter Threshold Time without Rain for Resetting STP (RAINT). The default value is 60 minutes at the ROC level, thus RAINT is currently not editable (Figure 17).

There are no rainfall categories or any VCP changes within the EPRE algorithm. If the EPRE determines that it is raining, accumulations will occur regardless of the weather mode or VCP. Just as was done previously with the NCA, the RAINA threshold will need to be set to reflect the typical coverage of residual clutter for each site.

It will still be necessary to address AP events with the appropriate clutter filtering. Unsuppressed AP will likely exceed the areal coverage threshold and initiate rainfall accumulations.

How to Determine Typical Residual Clutter

Supplemental Precipitation Data (SPD) Product

The Supplemental Precipitation Data (SPD) product is a text product available at the AWIPS workstation using the command WSRSPDXXX. The SPD can be put on an RPS list, or it can be requested. The SPD is generated each volume scan and contains information from the Precipitation Processing algorithms. The SPD is on the national RPS list for NWS sites, but will need to be requested from DoD radars. See Figure 18.

The “TOTAL RAIN AREA” provides the areal coverage of returns that exceed the dBZ threshold (RAINZ). Checking this value on several days where no precipitation or AP is present should provide an estimate of the typical areal coverage of residual clutter.

Exclusion Zones

Some WSR-88D sites have areas where appropriate clutter filtering cannot sufficiently remove non-meteorological returns and significant residual

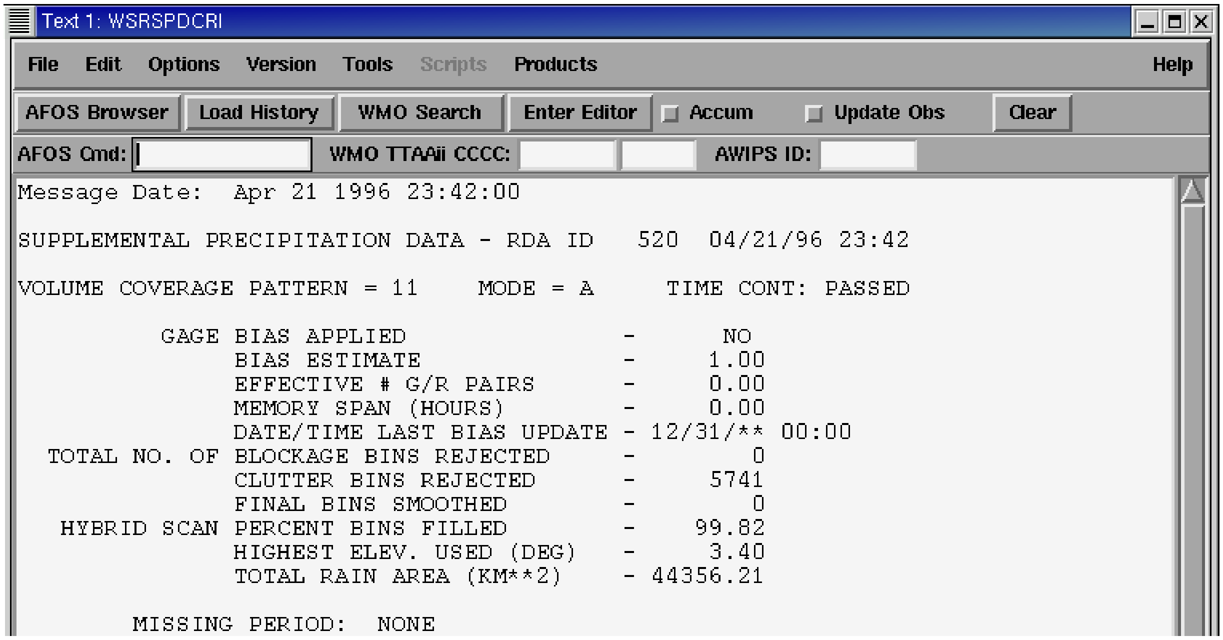


Figure 18. Supplemental Precipitation Data (SPD) product.

clutter remains. This type of residue is usually the result of:

- very high power from ground targets that cannot be entirely removed by the filters, such as mountain ranges
- moving ground targets like cars on an overpass, or
- stationary targets that are in motion, such as wind generators or wind blown trees.

The EPRE allows sites to define exclusion zones that remove the reflectivity data within these zones from precipitation processing. ***Exclusion zones are defined from azimuth to azimuth, range to range, and from the ground to a specified angle.***

The azimuth to azimuth definition must be in the clockwise direction and cannot cross 0°. If crossing 0° is necessary, two zones would have to be created. Up to 20 zones can be defined. It is ***required*** that the number of zones defined be specified (Figure 19).

Number of Exclusion Zones [NEXZONE]		5	0 <= X <= 20
Exclusion Zone Limits # 1	- Begin Azimuth #1	40.0	0.0 <= X <= 360.0, degrees
	- End Azimuth #1	70.0	0.0 <= X <= 360.0, degrees
	- Begin Range #1	50	0 <= X <= 124, nm
	- End Range #1	80	0 <= X <= 124, nm
	- Elevation Angle #1	1.0	0.0 <= X <= 19.5, degrees
Exclusion Zone Limits # 2	- Begin Azimuth #2	0.0	0.0 <= X <= 360.0, degrees
	- End Azimuth #2	35.0	0.0 <= X <= 360.0, degrees
	- Begin Range #2	25	0 <= X <= 124, nm
	- End Range #2	60	0 <= X <= 124, nm
	- Elevation Angle #2	1.0	0.0 <= X <= 19.5, degrees

Figure 19. Exclusion zones entries in the Hydromet Preprocessing parameters window. Two of the five zones defined at Albuquerque are displayed.

Clutter Regions Editor Window

The Clutter Regions editor window can be used to simplify the process of defining Exclusion Zones. The regions can be drawn in the Clutter Regions editor window. The azimuth and range coordinates that appear in the clutter regions table can then be typed into the Exclusion Zone fields in the Hydromet Preprocessing parameters window. Figure 20 depicts the Clutter Regions window used by the Albuquerque site during the RPG Build 5 beta test. These regions were drawn, then the coordinates were entered in the Hydromet Preprocessing parameters window in Figure 19.

AP/Clutter Removal

The legacy technique for AP/Clutter removal has been replaced with a new technique that has a very different approach.

Tilt Test Replaced

The legacy technique that has been replaced was called the Tilt Test. The test looked at the total areal coverage of returns for the lowest two elevations. If there was a significant reduction in areal coverage from 0.5° to 1.5°, it was assumed that the returns at 0.5° were from AP, and the entire 0.5° elevation was not used for precipitation pro-

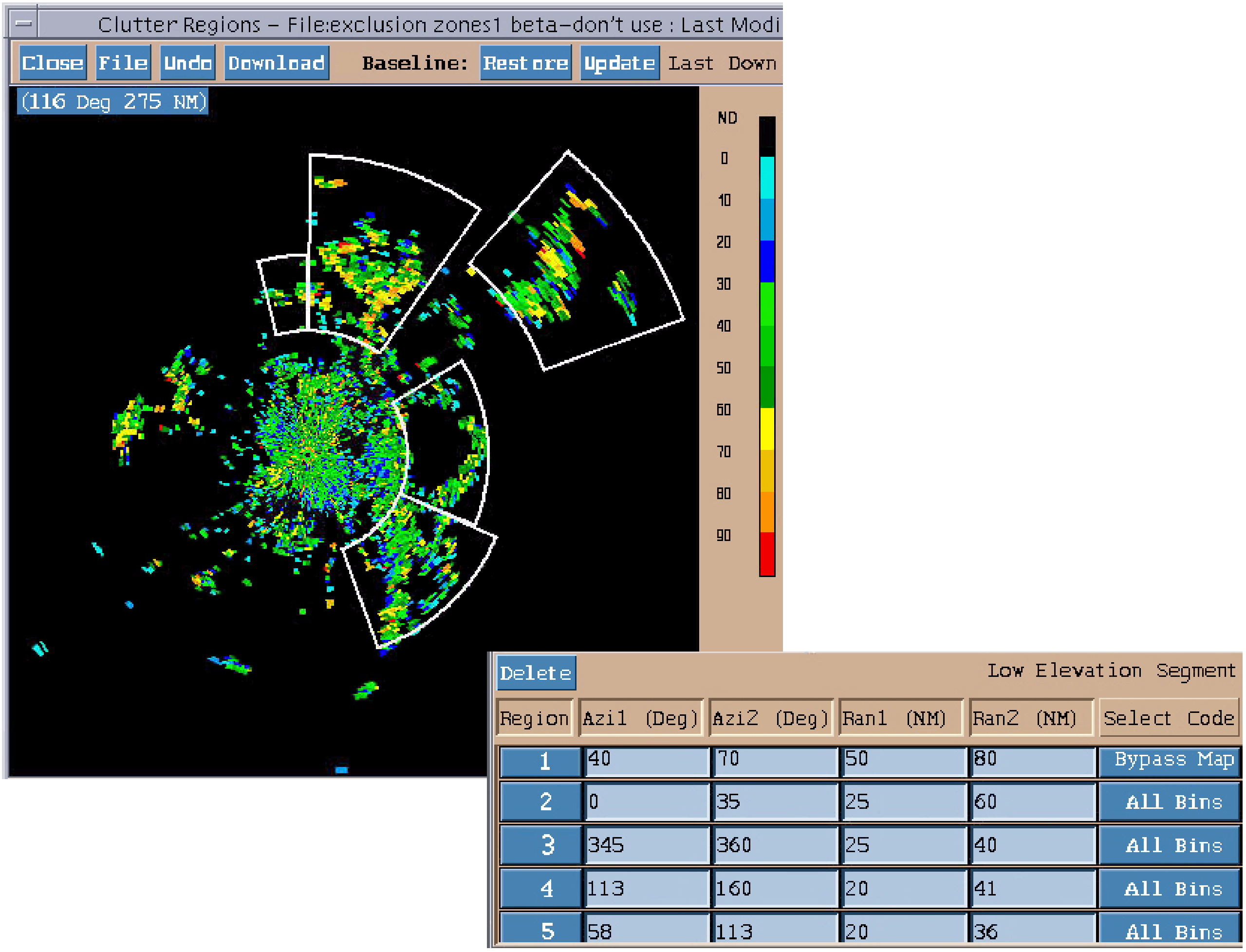


Figure 20. Clutter Regions editor window used by Albuquerque to define exclusion zones.

cessing. The lowest elevation available then becomes 1.5°. The Tilt Test has, at times, removed valid regions of precipitation, particularly in low-topped stratiform rainfall events.

Radar Echo Classifier (REC)

The EPRE uses the Radar Echo Classifier (REC) algorithm to identify AP/Clutter. The REC processes all three moments of the base data. For a particular range bin, the REC assigns a likelihood, as a percentage, that the returns are from clutter. The REC generates two products that display the likelihood percentages, Clutter Likelihood Reflectivity (CLR) and Clutter Likelihood Doppler (CLD).

The EPRE uses these percentages to reject data suspected as clutter. An adaptable parameter, the Maximum Allowable Percent Likelihood of Clutter (CLUTTHRESH), identifies which bins will be rejected from precipitation processing because the returns are likely to be from clutter.

The default value for CLUTTHRESH is 50% (Figure 21). Thus if the % ≤ 50, a range bin reflectivity value is retained and if the % > 50, the range bin reflectivity is rejected. If the range bin reflectivity value is not used, the reflectivity value for the next higher elevation will be tested for use for that bin.

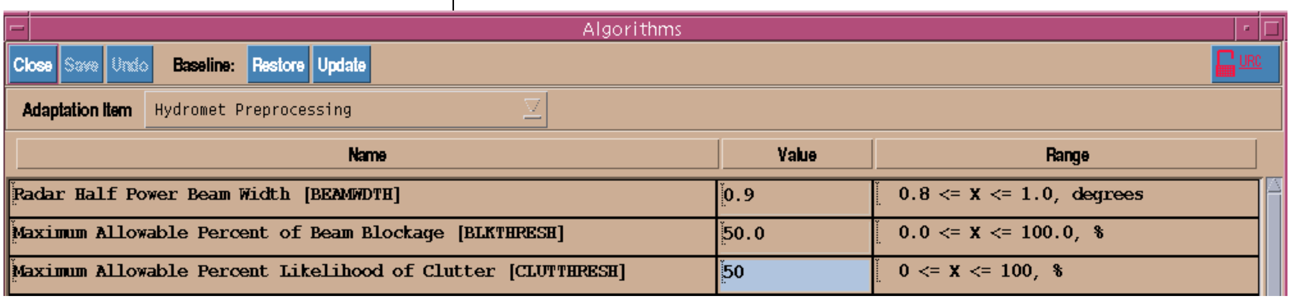


Figure 21. Clutter threshold entry in the Hydromet Preprocessing parameters window.

Though likely to be a rare event, it may be desirable to increase the CLUTTHRESH value if there is a suspicion that real precipitation is being removed as clutter. This problem may occur in areas of mixed AP and precipitation.

REC Performance in Range Folded Areas

Since the REC AP/Clutter identification process uses all three base moments, it will perform best in regions where valid velocity data are available. In areas of range folding, the REC results are based only on the reflectivity data, and are less reliable. Reflectivity values from radar bins with valid precipitation in areas of range folding may be replaced by values from higher elevations, potentially degrading rainfall estimates in flash flooding. In a case where extensive range folding corresponds with valid precipitation, increasing CLUTTHRESH may be desirable.

The EPRE's reliance on the REC to identify AP/Clutter will allow for the use of significantly more reflectivity data from lower tilts compared to the Tilt Test.

REC Performance in Case Studies

The REC has performed well in case studies where there is AP mixed with precipitation. However, in cases where there is widespread AP, the REC has not always identified it. The residual AP has been apparent on the precipitation products.

To mitigate the problem of residual clutter (normal or AP) close to the RDA, some of the lower elevation angles are not used at close ranges. This solution is similar to the legacy hybrid scan, where fixed elevations were used at fixed ranges. The result is an occasional ring structure on the products.

See "EPRE Effects on Precipitation Product Appearance" on page 32 for product examples of both residual AP and rings near the RDA.

EPRE Hybrid Scan

With the EPRE algorithm, the hybrid scan construction is no longer limited to the lowest four elevation angles. Starting with the 0.5° elevation, the reflectivity value for each range bin is accepted based on the following criteria:

1. Beam blockage no more than 50%,
2. Does not fall within an exclusion zone, and
3. The REC clutter likelihood is no more than 50% (CLUTTHRESH).

If any of these conditions are ***not*** met, the reflectivity value from the next higher elevation is checked.

The construction of the hybrid scan continues until it is at least 99.7% full. On the SPD product (Figure 18), the Hybrid Scan Percent Bins Filled is listed for each volume scan. For most sites, this process is completed within the lower 2 or 3 elevations. For more mountainous sites, the lower 4 or even 5 elevations (especially with VCP 12) will be needed to build the hybrid scan. Thus the availability of precipitation products within the volume scan will vary somewhat from site to site.

Note that the EPRE will allow for more use of low level reflectivity values for precipitation processing than the legacy algorithm.

EPRE Effects on Precipitation Product Appearance

Due to the EPRE's techniques for removing residual clutter and AP, there are features of the precipitation products that may occur more frequently than with the legacy algorithm.

AP and Residual Clutter from Terrain

Results from case studies with the EPRE have shown that in widespread AP events, particularly where the AP has not been appropriately filtered at the RDA, the AP will show up on the precipitation products. See Figure 22 and Figure 23 for an example of ***unfiltered AP*** that is not successfully identified by the REC algorithm, and thus not removed by the EPRE. In Figure 22, a line of showers is southeast of the RDA, with a large area of AP north and west.

In Figure 23, the One Hour Precipitation (OHP) product shows that most of the AP was not successfully identified by the REC and thus not

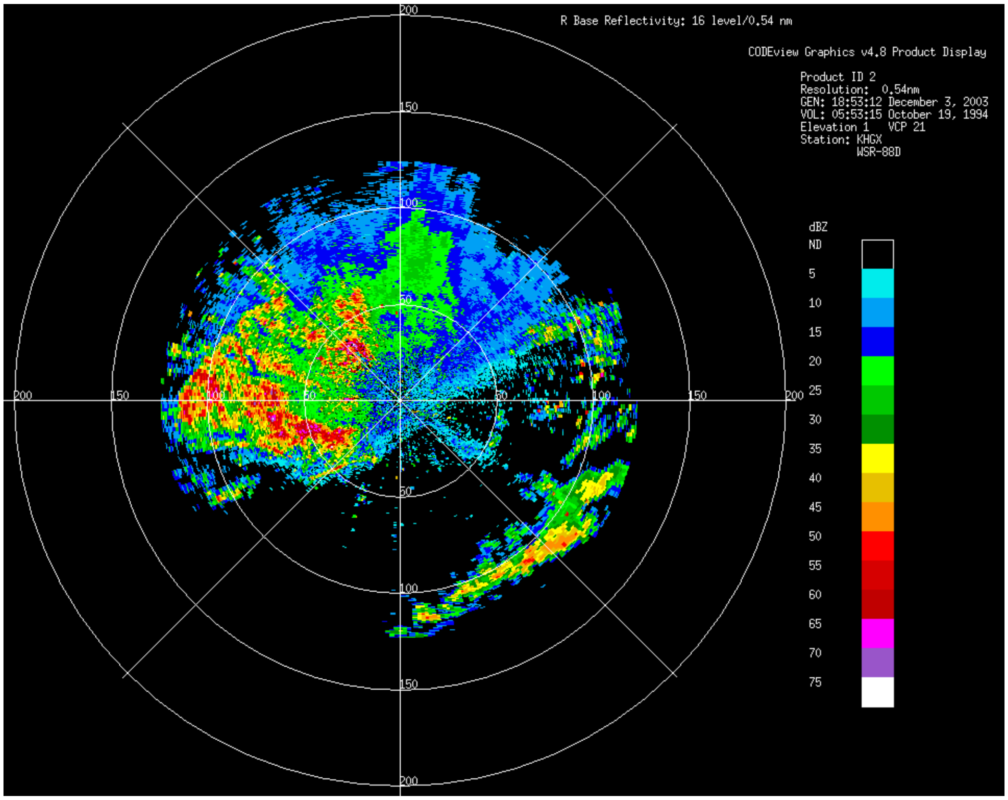


Figure 22. Significant AP to the north and west with a line of showers to the southeast.

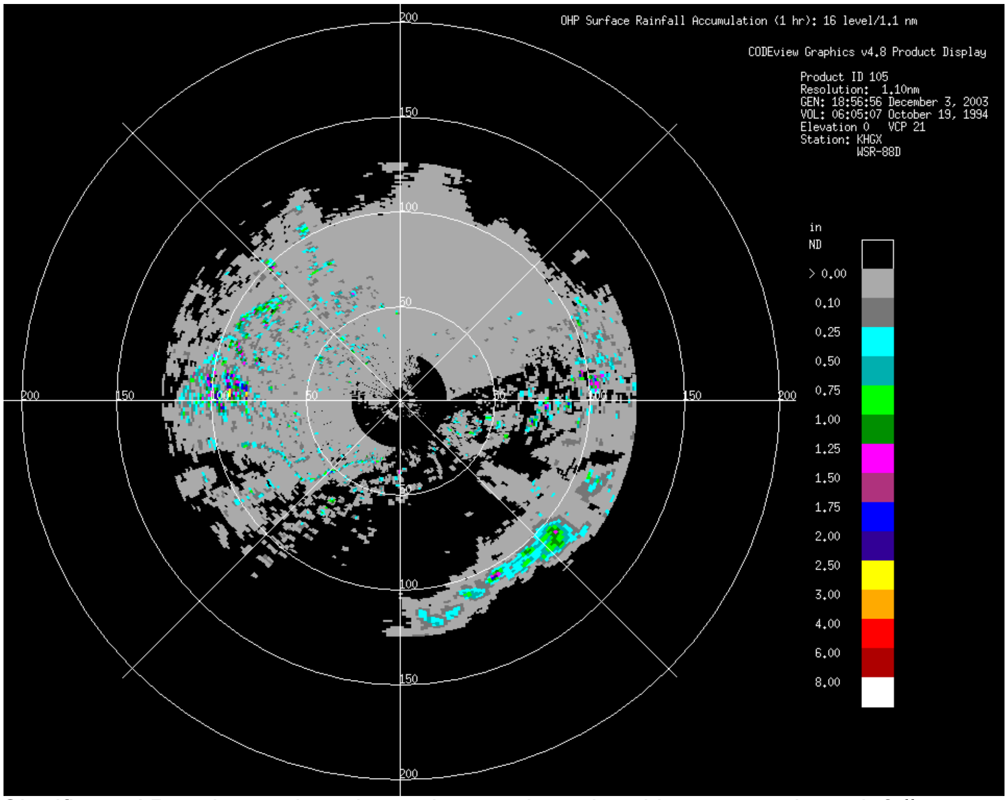


Figure 23. Significant AP to the north and west is not rejected and is converted to rainfall accumulations.

removed by the EPRE. Also note the ring structure close to the RDA. This is a result of the exclusion of lower elevations at close ranges.

For sites that have mountainous terrain, residual clutter is a typical problem. Careful adjustment of the RAINA parameter and creation of exclusion zones may be needed to avoid contamination of precipitation products. As with AP, residual clutter may not be successfully identified by the REC and thus not removed by the EPRE. In Figure 24, residual clutter is in numerous locations associated with mountain ranges. In Figure 25, some of this clutter has been accumulated in the Storm Total Precipitation (STP) product.

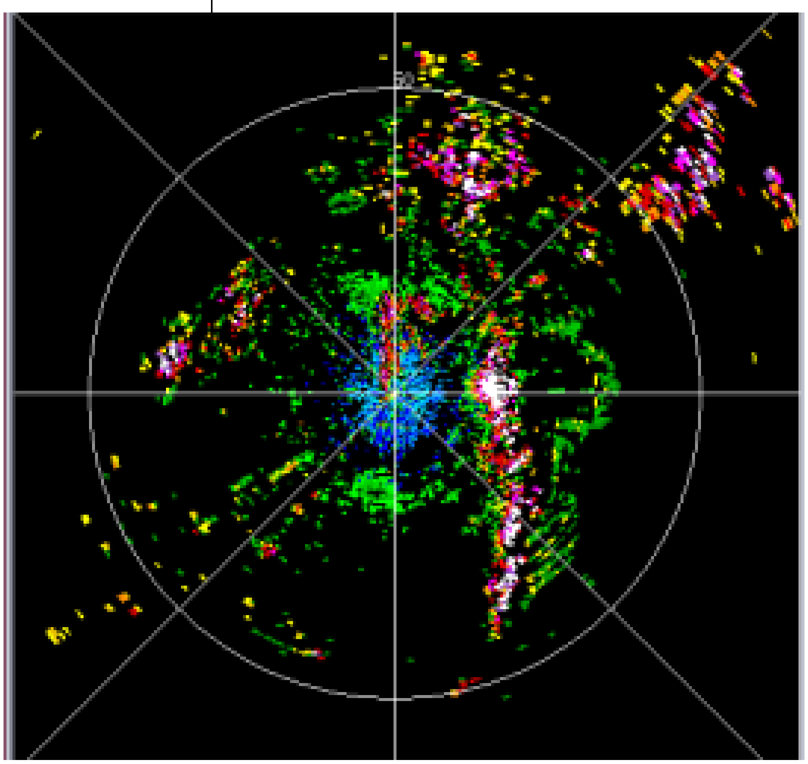


Figure 24. Residual clutter on Base Reflectivity resulting from mountainous terrain.

Ring Structure Near the RDA

To mitigate residual clutter and potentially high accumulations close to the RDA, some of the lower elevations are excluded at close ranges. Specifically:

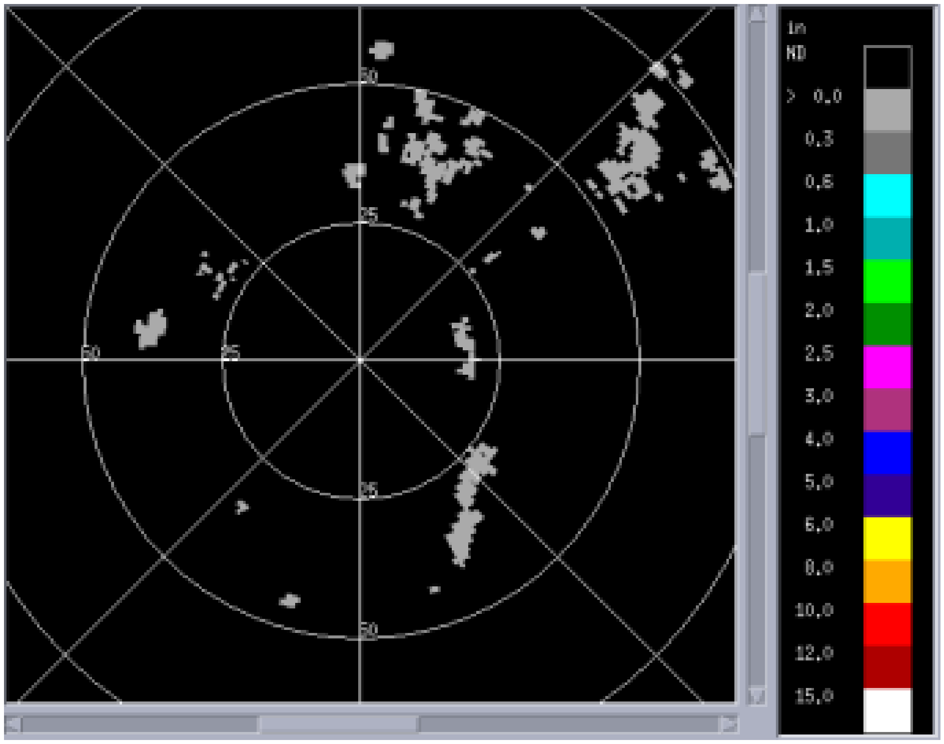


Figure 25. Residual clutter from mountainous terrain on a Storm Total Precipitation product.

- From 0 to 5 nm, all elevations at or below 1.6° are excluded.
- From 5 to 9 nm, all elevations at or below 1° are excluded.
- From 9 to 25 nm, all elevations at or below 0.6° are excluded.

The result is an occasional ring structure close to the RDA on the precipitation products. In Figure 26, this structure is apparent on an STP product. Near the range of 25 nm, the returns are from 1.5° since 0.5° is excluded. Just beyond 25 nm, the rainfall is based on returns from 0.5°. This ring structure will be most apparent in low topped stratiform events and least likely with deep convection.

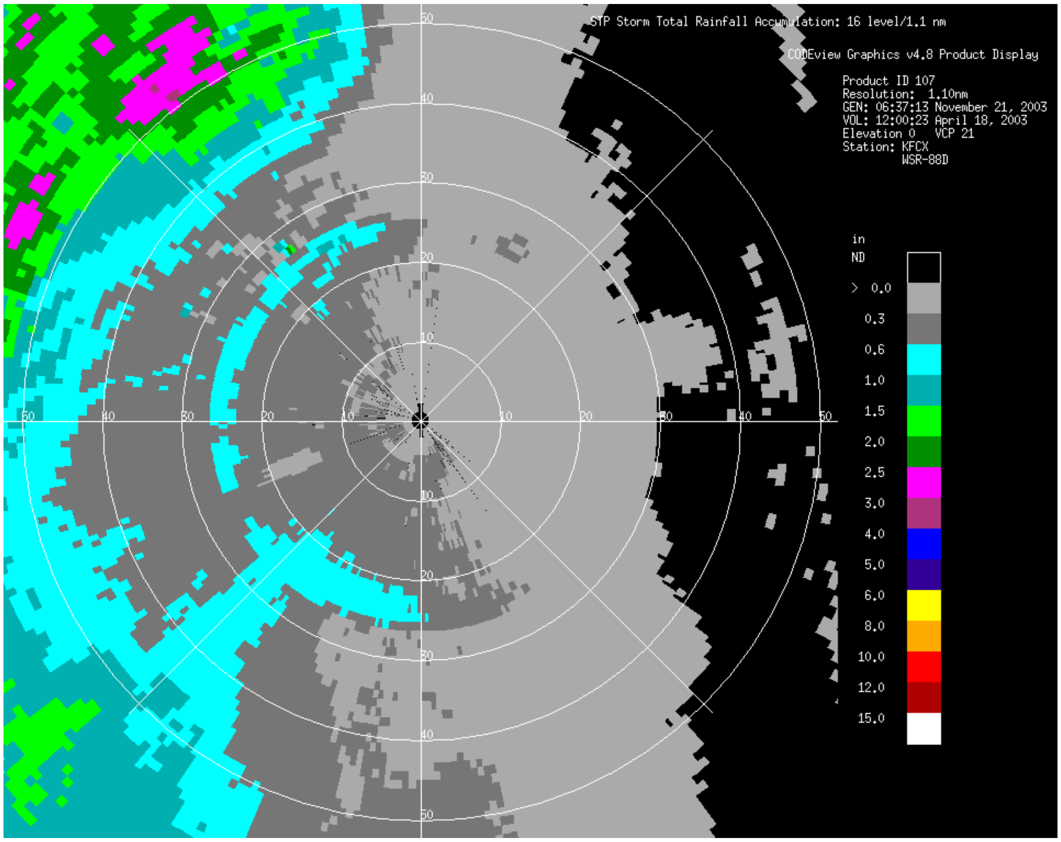


Figure 26. Ring structure close to the RDA on a Storm Total Precipitation product.

4. Mesocyclone Detection Algorithm (MDA), Phase 1

The Mesocyclone Detection Algorithm (MDA) is significantly different than the legacy Mesocyclone Algorithm. The MDA will not initially replace the Mesocyclone Algorithm. Both algorithms are expected to run at the RPG for about one year. The MDA products are planned to be available for display on AWIPS with OB 4.

Compared to the legacy Mesocyclone Algorithm, the MDA is designed to detect a broader spectrum of storm-scale vortices, including circulations meeting weaker strength criteria than traditional mesocyclones, and circulations associated with low-topped thunderstorms and squall-lines. Statistical analyses of large storm-scale vortex data sets (e.g. studies used to develop NWS Tornado Warning Guidance) show that some vortices that do not meet traditional mesocyclone strength and depth criteria can still be associated with tornadoes.

The circulations will no longer be classified as MESO, 3D SHR, or UNC SHR. They will be classified as MESO or CIRCULATION based on their “Strength Rank” value and age.

Strength Rank

Detected circulations will be assigned a “Strength Rank” and this value will determine product appearance, such as a thick vs. a thin circle. Additional information such as forecast positions, time trends, and time-height trends will also be available in Build 6. The MDA product will contain a large data array of rotation characteristics that will support analysis of the vertical structure and temporal evolution of all radar detected shears.

MDA Adaptable Parameters

Though MDA products will not be available for AWIPS display until OB 4, there are adaptable parameters for MDA with RPG Build 5. The parameters are at the URC level (Figure 27). The default values for these parameters will provide MDA performance that is similar to the legacy Mesocyclone Algorithm, and it is recommended that these values stay at default until Build 6.

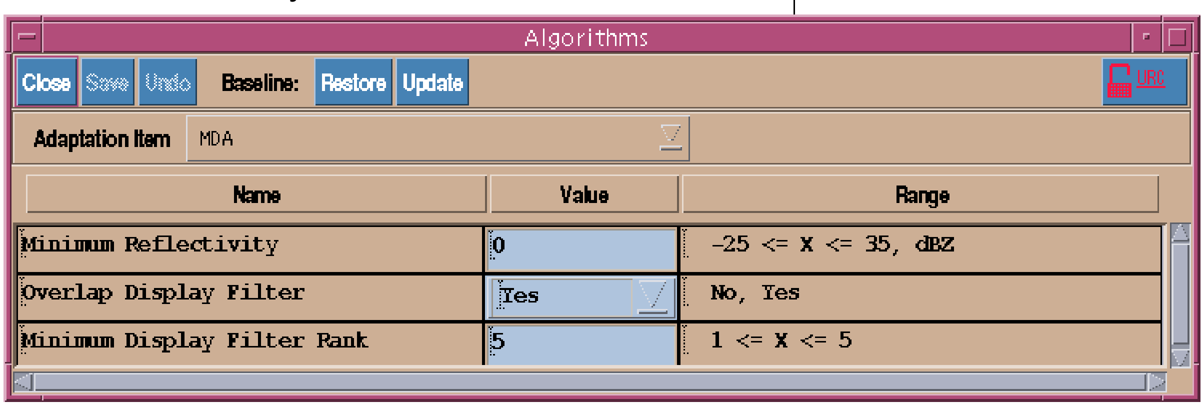


Figure 27. MDA adaptable parameters.

More extensive training on MDA will be available with RPG Build 6 and AWIPS OB 4.

5. Tornado Detection Algorithm Rapid Update (TRU)

The Tornado Detection Algorithm Rapid Update (TRU) functions similarly to the Mesocyclone Rapid Update (MRU) which was released with RPG Build 4 and displayable with AWIPS OB 2. The TRU will generate a product for each elevation angle through a volume scan with the results of the Tornado Detection Algorithm (TDA). The TRU products are planned to be available for display on AWIPS with OB 4, with the deployment scheduled to begin in September of 2004.

More extensive training on TRU will be available with AWIPS OB 4.

6. Changes to Support Real-time Level II Data Collection

The need to transition from the legacy Level II recorders at the RDA to a more efficient system for data collection has long been recognized. A proof of concept project, the Collaborative Radar Acquisition Field Test (CRAFT), which began in 1999, has matured such that by early 2004, more than 100 sites were routinely distributing Level II data to NCDC in real-time. This eliminates the need to record data at the RDA, retrieve tapes and ship them to NCDC.

Build 5 provides the necessary software to transition all NWS sites and 11 DoD CONUS sites to send Level II data to NCDC and other users in real-time using the RPG. In addition to Build 5, a hardware installation will be required for implementation.

For those sites that are already performing real-time Level II distribution, some of the existing hardware will still need to be replaced.

Access to the Base Data Distribution System (BDDS) to start and stop the real-time Level II data distribution is through the BDDS HCI button on the Master System Control Function (MSCF) window (Figure 28).

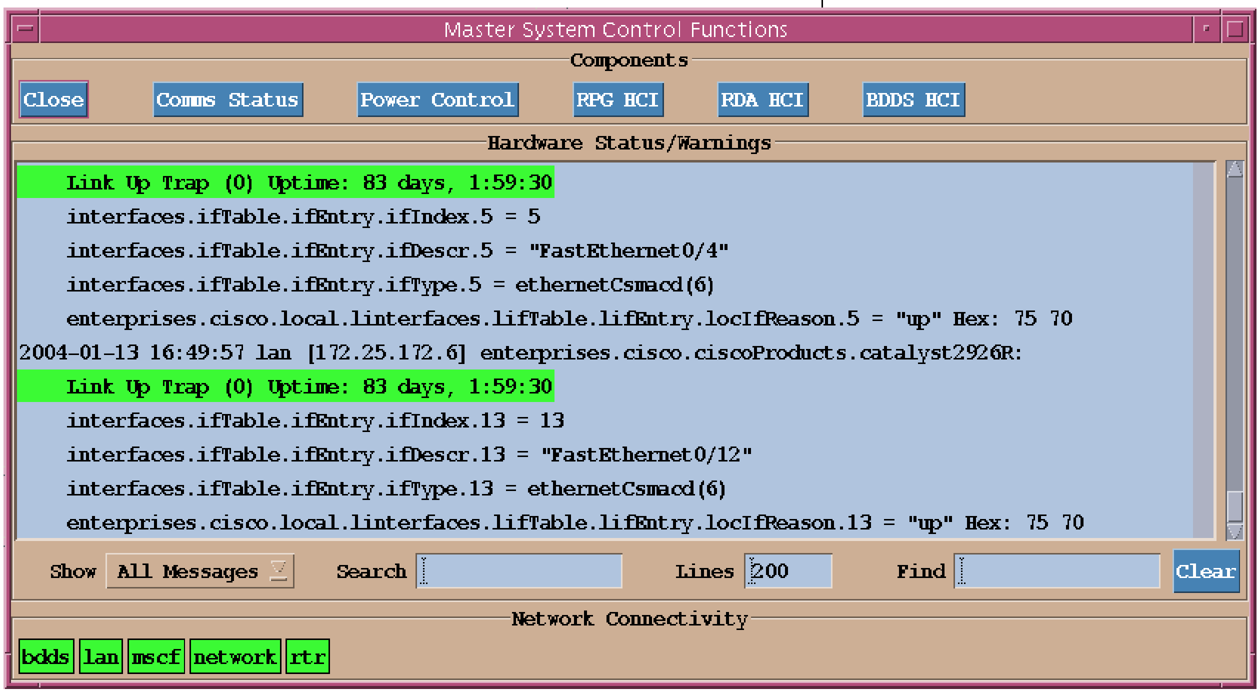


Figure 28. MSCF window.

These radar data will go to support the NWS, DoD, and FAA missions, universities for research, other federal agencies, and the private sector.

Starting and stopping the Archive II data flow from the BDDS will need to be done from time to time. For example, on-line maintenance at the RDA sometimes results in test signals or other non-meteorological radar images. To avoid sending this type of data to NCDC and external users, the Archive II data flow would need to be temporarily stopped. In Figure 29, the Stop and Start Archive II buttons are used to stop and start the Archive II data flow. While Archive II is running, the “Active” status would seem to imply that the data are flowing. However, this entry only implies that the necessary connections are in place.

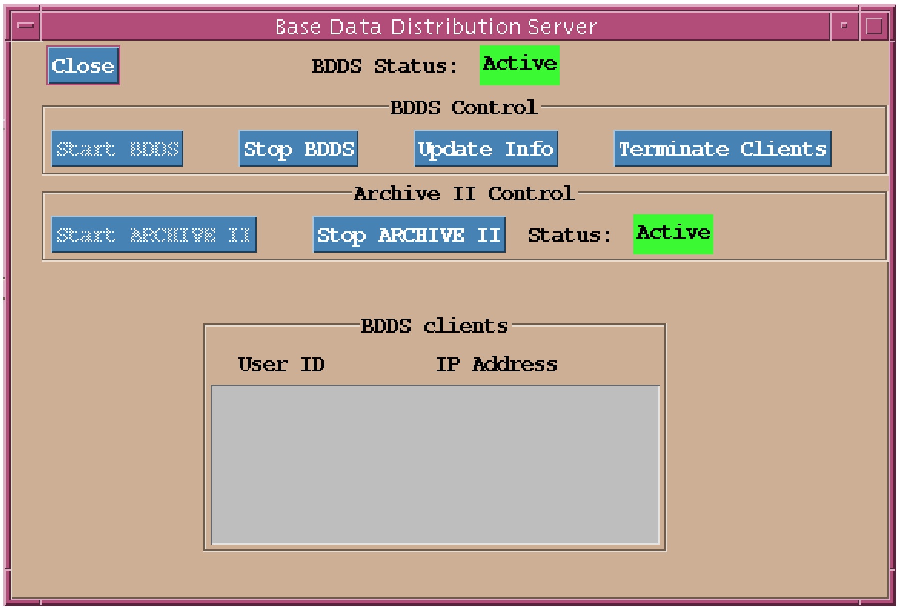


Figure 29. BDDS HCI with start and stop buttons for real-time Archive II.

7. Communications Upgrades

Frame Relay for DoD and FAA Radars Controlled from NWS WFOs

The upgrade to Frame Relay communications is a Build 5 software change that will require a hardware upgrade and AWIPS OB 3 for implementation. The hardware installation will be conducted by a ROC installation crew. This installation is currently scheduled for this Spring and Summer.

Frame Relay will provide a significant improvement for NWS sites receiving products from and issuing control commands to DoD and FAA radars. The slow line speed of this connection has limited product availability from DoD and FAA radars at NWS offices. The Frame Relay circuits are expected to accommodate a 50 product RPS list.

There are some NWS sites that have DoD radars in their CWA that are controlled by some other NWS office. Therefore, their access to products from that DoD radar will remain limited until additional communications upgrades become available.

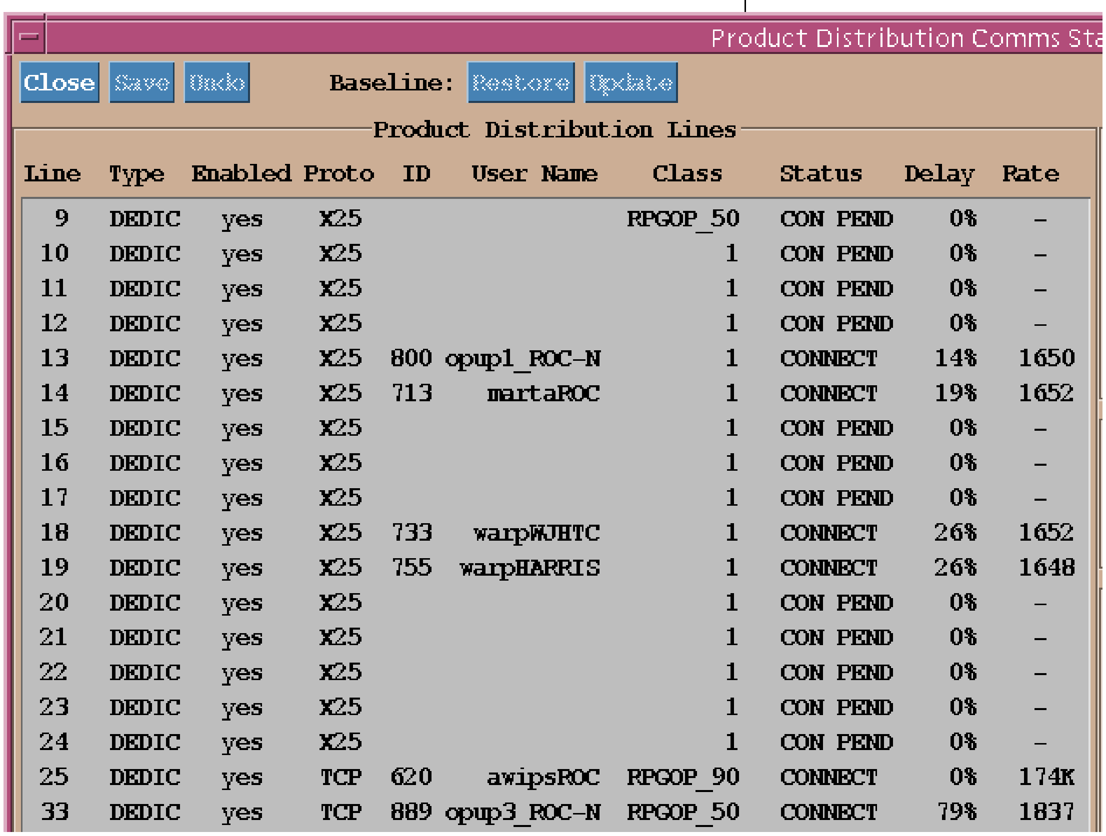
Use of AWIPS WAN for OTRs

With AWIPS OB 3, One Time Requests (OTRs) from one NWS site to another will be routed through the AWIPS WAN. This will provide much faster responses to OTRs.

Once the Frame Relay communications are in place, NWS sites can then send OTRs to DoD and FAA radars that are controlled from an NWS office.

8. Changes to the Product Distribution Comms Status Window

Some of the information on the Product Distribution Comms Status window has changed with Build 5 (Figure 30). There are two entries that are new:



Line	Type	Enabled	Proto	ID	User Name	Class	Status	Delay	Rate
9	DEDIC	yes	X25			RPGOP_50	CON PEND	0%	-
10	DEDIC	yes	X25			1	CON PEND	0%	-
11	DEDIC	yes	X25			1	CON PEND	0%	-
12	DEDIC	yes	X25			1	CON PEND	0%	-
13	DEDIC	yes	X25	800	opup1_ROC-N	1	CONNECT	14%	1650
14	DEDIC	yes	X25	713	martaROC	1	CONNECT	19%	1652
15	DEDIC	yes	X25			1	CON PEND	0%	-
16	DEDIC	yes	X25			1	CON PEND	0%	-
17	DEDIC	yes	X25			1	CON PEND	0%	-
18	DEDIC	yes	X25	733	warpWJHTC	1	CONNECT	26%	1652
19	DEDIC	yes	X25	755	warpHARRIS	1	CONNECT	26%	1648
20	DEDIC	yes	X25			1	CON PEND	0%	-
21	DEDIC	yes	X25			1	CON PEND	0%	-
22	DEDIC	yes	X25			1	CON PEND	0%	-
23	DEDIC	yes	X25			1	CON PEND	0%	-
24	DEDIC	yes	X25			1	CON PEND	0%	-
25	DEDIC	yes	TCP	620	awipsROC	RPGOP_90	CONNECT	0%	174K
33	DEDIC	yes	TCP	889	opup3_ROC-N	RPGOP_50	CONNECT	79%	1837

Figure 30. Product Distribution Comms Status window.

1. Delay: Any delay in product distribution from the RPG is displayed as a percentage of current VCP update time. For example, a delay of 50% during VCP 11 would mean products would be delayed by 2.5 minutes, 25% would mean 1.25 minutes, etc. This information may be helpful during weather events with widespread echo coverage, which results in increased product sizes and distribution delays.
2. Rate: This is the estimated current transmission rate for a given distribution line. Units are integers representing bytes, kilobytes, or megabytes/seconds. For example, a value of 1 in the Rate column = 1 byte/second, 1K = 1 kilobyte/second, 1M = 1 megabyte/second.

Summary of Dependencies

In summary, the availability of RPG Build 5 features has the following associated dependencies:

RPG Build 5

- MPDA, using VCP 121
- EPRE
- Delay and Rate information on the Product Distribution/Comms window

RPG Build 5 and hardware install

- Real-time Level II data collection

RPG Build 5 and AWIPS OB 3

- VCP 12
- AWIPS WAN for OTRs

RPG Build 5, AWIPS OB 3 and hardware install

- Frame Relay for DoD and FAA radars controlled by WFOs

RPG Build 5 and AWIPS OB 4

- MDA Phase I
- TRU

Lessons Learned from the RPG Build 5 Beta Test

1. The Clutter Regions window can be used to support the process of generating exclusion zones (page 28).
2. Due to the higher antenna rotation rates of VCPs 12 and 121, higher returns from clutter targets (mountains) were noted by two of the Beta sites. The solution was to create a separate clutter regions file for these particular VCPs, employing high suppression. These events were confined to the low segment. If enhanced reflectivities in known clutter areas are noted associated with VCPs 12 and/or 121, adjust clutter filtering to high using a ***separate*** clutter regions file. Do not apply high suppression to the legacy VCPs also!
3. An RDA alarm, called an AU parity error, has been noted at most of the beta sites when using VCP 121. This will show up as a red banner along the bottom of the RPG HCI every 3rd volume scan. No action is required when this occurs, as it will not impact operations.

RPG Build 5 Release Notes

The RPG Build 5 Release Notes are available at

http://www.roc.noaa.gov/ops/orpg_rel_notes.asp